States
Department of
Agriculture

Forest
Service

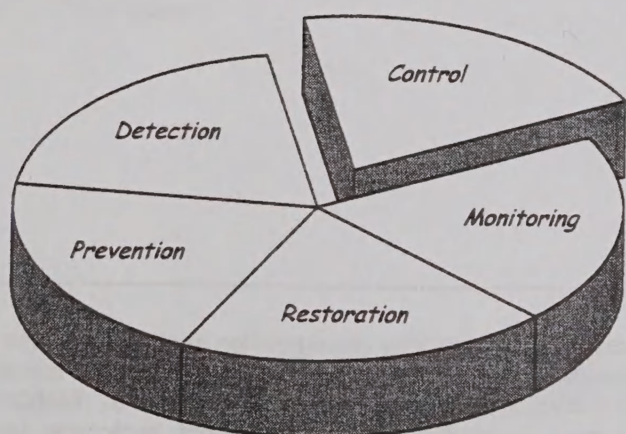
November 2006

Final Environmental Impact Statement

Weed Management

Custer National Forest

Carbon, Stillwater, Sweet Grass, Park, Powder River, Rosebud, and Carter Counties of Montana and Harding County of South Dakota



CUSTER NATIONAL FOREST
WEED MANAGEMENT
Final Environmental Impact Statement

Lead Agency: **USDA Forest Service**

Responsible Official: **Nancy T. Curriden, Forest Supervisor**
Custer NF, 1310 Main St., Billings, MT 59105

For Information Contact: **Kim Reid, Project Coordinator**
Custer NF, 1310 Main Street
Billings, MT 59105
(406) 657-6205 ext. 233

Abstract: The Forest Service is updating the 1987 weed control decisions. The Final Environmental Impact Statement documents the analysis for a reasonable course of action given new problems, options and opportunities to combat noxious weeds and other undesirable plants. Earlier decisions did provide the Forest with the ability to be more effective in treating increasing weed infestations. Noxious weeds and other invasive species are reducing ecological productivity, spreading to nearby non-infested lands, and increasing the economic burden on private landowners and state/federal taxpayers. The decision made involves these questions:

- Where and what kind of weed controls will be used
- What adaptive management and protective measures will be required to appropriately implement weed control methods
- Whether aerial application of herbicides can be implemented

Three alternatives were developed to address these objectives. Alternative 1 includes all integrated pest management (IPM) methods used for existing weed control, use of new herbicides, herbicide use within the Absaroka- Beartooth Wilderness Area, and aerial application of herbicides outside of Wilderness. Alternative 2 is to use all integrated pest management methods, but without the use of herbicides. Alternative 3 takes no action to change the current integrated pest management including ground based herbicide treatment with only four herbicide choices, and no herbicide use within the A-B Wilderness Area. The selected alternative is Alternative 1.

TABLE OF CONTENTS

CHAPTER 1

PROPOSED ACTION - PURPOSE AND NEED

INTRODUCTION

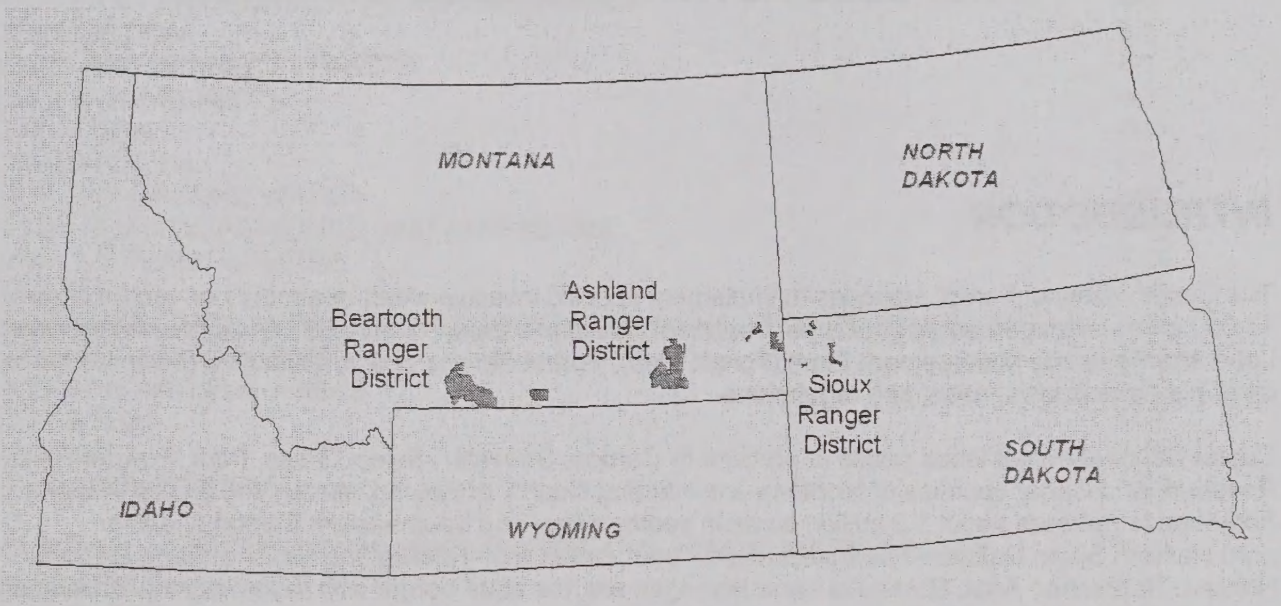
The Custer National Forest proposes to implement specific invasive weed treatments on approximately 14,000 gross managed acres (1,500 net treatment acres) in support of the 1987 Custer National Forest Land and Resource Management Plant (Forest Plan), Forest Service policy, Executive Order 13112, and other public land laws, rules, and regulations.

Custer National Forest lands reside in portions of Carbon, Stillwater, Sweet Grass, Park, Powder River, Rosebud, and Carter counties of Montana and Harding County of South Dakota. The Custer National Forest encompasses about 1.2 million acres in south central and southeastern Montana, and in northwestern South Dakota. The Forest shares boundaries with Yellowstone National Park, Bighorn National Recreation Area, Bureau of Land Management, the state border with Wyoming, the Gallatin and Shoshone National Forests, the Crow and Northern Cheyenne Indian Reservations, and numerous state and private lands. The project area covers the entire Custer National Forest, and includes existing, as well as future potential weed infestation areas. See Vicinity Map below for the project area location.

This Environmental Impact Statement (EIS) has been prepared to disclose the environmental effects of a proposal to expand upon the current Custer National Forest weed control program. When developing a weed management strategy it is critical to consider all available resources and tools. The integrated pest management (IPM) strategies utilize various weed management options that focus on the most economical and effective control of weeds. Anything that weakens the weed, prevents spreading, or prevents seed production can be a valuable tool. Proposed methods to control invasive weeds include a combination of ground and aerial application of herbicides, mechanical, biological, and cultural weed treatments. This document follows regulations as defined by the Council of Environmental Quality for implementing procedural provisions of the National Environmental Policy Act of 1969 (NEPA, as amended, 40 CFR1500-1508); US Forest Service Environmental Policy and Procedures Handbook (FSH 1909.15); and US Forest Service Handbooks 2109 Pesticide Use Management and 3409 on Forest Pest Management.

The current weed control program provides for annual control or containment of noxious and other undesirable weeds on the Custer National Forest (CNF) under the umbrella of an overall integrated pest management strategy. However, the current 1987 Environmental Impact Statement and subsequent National Environmental Policy Act decisions for weed control on the CNF did not authorize use of herbicides in the Absaroka - Beartooth Wilderness Area, nor did it analyze effects of new herbicides or aerial application of herbicides. This analysis will assess forest-wide treatment effects, and application of adaptive management strategies for new weed infestations.

VICINITY MAP



DOCUMENT STRUCTURE

The Forest has prepared this environmental impact statement in compliance with the National Environmental Policy Act and other relevant federal and state laws and regulations. This document is organized into chapters, appendices, and map section.

Additional documentation, including detailed analyses of the project can be found in the project record at the Custer National Forest's Supervisor's Office, Billings, Montana.

BACKGROUND

The term "weed" means different things to different people. In the broadest sense, it is any plant growing where it is not wanted. Generally, weeds are defined in terms of interference with the economic value of the land. Weeds can be native or non-native, invasive or non-invasive, and noxious or not noxious. Legally, a noxious weed is any plant designated by a Federal, State or county government as injurious to public health, agriculture, recreation, wildlife or property. The establishment and spread of invasive weeds often may signal the ecological decline of entire watersheds because of the detrimental impact of their spread on the diversity of plant communities. Declines in vegetative diversity are usually quickly followed by declines in plant and animal diversity. Implementing weed management strategies early while infestations are manageable reduces the economic, cultural, and environmental impact these populations can have on the ecosystem and economy.

In order to maintain consistency during this analysis, the following definitions are used to describe the classification of these undesirable plants on the Custer National Forest.

- **Exotic Plants:** In most cases, plants not native to North America.
- **Noxious Weeds**: A legal term, these are exotic plants regulated by law that are aggressive, difficult to manage, and invasive. These species may displace or significantly alter native plant communities.

TABLE 1 - 1. CHANGE IN INVENTORY ON THE CUSTER NF

District	Species	Scientific Name	1985 Inventoried Net Acres[1]	2006 Inventoried Net Acres
Beartooth	Leafy Spurge	*Euphorbia esula*	3	14
	Spotted Knapweed	*Centaurea maculosa*	114	128
	Dalamtian toadflax	*Linaria dalmatica*	12	5
	Canada Thistle	*Cirsium arvense*	6	143
	Sulfur cinquefoil	*Potentilla recta*		9
	Yellow toadflax	*Linaria vulgare*		4
	Oxeye Daisy	*Chrysanthemum leucanthemum*		4
	Common Tansy	*Tanacetum vulgare*		3
	Houndstongue	*Cynoglossum officinale*		58
	Field Bindweed	*Convolvulus arvense*		0
	Tall Larkspur	*Delphinium occidentale*	Present	57
Subtotal			135	368 + larkspur (57)
Sioux	Leafy Spurge	*Euphorbia esula*	150	24
	Spotted Knapweed	*Centaurea maculosa*	40	14
	Canada Thistle	*Cirsium arvense*	10	749
	Houndstongue	*Cynoglossum officinale*		24
	Other			21
Subtotal			200	831
Ashland[2]	Leafy Spurge	*Euphorbia esula*	32	10
	Spotted Knapweed	*Centaurea maculosa*	454	192
	Russian Knapweed	*Centaurea repens*	21	20
	Canada Thistle	*Cirsium arvense*	14	
	St. Johnswort	*Hypericum perforatum*	1	
	Houndstongue	*Cynoglossum officinale*		2
Subtotal			522	224
CNF Total			857	1422

This increase in inventory is due to spread, large scale wildfires, and better inventory. The total cost of control is greater than the Forest is budgeted to accomplish on an annual basis. In addition to annual appropriations, various grants and partnerships have been successful in adding resources to annual control measures. Priority criteria are used because resources are generally not sufficient to treat all infestations (see Appendix E).

Detailed locations of weeds by Ranger District are located in the project record. They are also displayed in the map section and in Chapter 3, Tables 3 - 1, 3 - 2, and 3 - 3.

Appendix A displays the Custer National Forest's current list of undesirable weeds of specific concern (53 species). Each species is identified by category by state, county, or Greater Yellowstone Coordinating Weed Committee lists.

PURPOSE OF AND NEED FOR ACTION

Invasive weeds are threatening or dominating areas of the Forest with negative impacts on native plant communities, wildlife habitat, soil and watershed resources, recreation, and aesthetic values. A shift from native vegetation to invasive weeds decreases wildlife forage, reduces species diversity, and increases soil erosion due to a decrease in surface cover. For these reasons it is imperative to aggressively manage weeds across the Forest.

The purpose and need of the project is to prevent and reduce loss of native plant communities associated with the spread of weeds. Specifically, the purposes of this project are to treat weeds within the Custer

[1] The 1985 inventory was taken from the 1986 Custer Forest Plan.
[2] The 2006 inventory for the Ashland Ranger District is generally less than what was reflected in the 1985 inventory. This is due to successful broadcast treatment of spotted knapweed and continued treatment of spurge.

National Forest, and to reduce the impact of weeds on other resources. The specific purposes of this proposal are described below, together with discussions of the ecological and management needs:

Purpose 1: This EIS provides the opportunity to update and integrate the 1987 weed control decisions with use of new herbicides and biological control, utilize herbicides as a tool in the A-B Wilderness Area, and aerially treat specific areas outside of the Wilderness. The 1987 environmental analyses are incorporated into this analysis by reference.

Need: There is a need to review the Custer National Forest's current management strategies and tactics to evaluate a reasonable course of action given new problems, options and opportunities. Existing decisions do not allow the CNF to keep up with weeds introduced at a faster rate than anticipated in the previous analysis. The speed of introduction or spread is increasing because:

- Large infestations are appearing on lands adjacent to National Forest as a rapid increase of users from weed-infested areas travel to National Forests.
- New weed species are invading areas not considered in previous decisions.
- Changes in types of use, Off-highway vehicles for example, increase the opportunity for and the rate of infestations.
- Controls do not match the rate of infestation in remote inaccessible areas, because weeds go untreated. Aerial herbicide application is not authorized under existing weed programs, which limits potential treatment options in these more inaccessible areas. As a result, control efforts only slow the spread of weeds on the Forest rather than contain or eradicate infestations.
- Large area wildfires have created massive seedbeds for invasion by weeds.

In order to update and refine current Forest weed control program the following developments were considered.

- Seed spread by the increase of all types of recreational and commercial use on the Forest.
- Changes in sites, modes and rates of weed spread and the impact on Forest use.
- Introduction of new weed species.
- Identification of other undesirable weeds such as poisonous plants (i.e., tall larkspur) and weeds interfering with infrastructure investments (i.e., creating cracks along paved road shoulders).
- Improved tools such as recently registered herbicides and use of aerial application methods.

INTEGRATED WEED MANAGEMENT

Integrated weed management is an ecologically based process for selecting strategies to regulate weeds to achieve resource management objectives. It is the planned and systematic use of detection, evaluation, and monitoring techniques; and all appropriate silvicultural, biological, chemical, genetic, and mechanical tactics needed to prevent or reduce weed-caused damage and losses to levels that are economically, environmentally, and aesthetically acceptable. The integrated weed management approach developed for this project does not center on treatment methods but rather on a multi-faceted strategy that includes education, inventory, ecological impact and risk assessment, prioritizing treatment areas, choosing management techniques, evaluating the program through monitoring and adapting as the program evolves. The overall goal of integrated weed management is to maintain or restore healthy plant communities that are relatively weed resistant, while meeting other land-use objectives such as forage production, wildlife habitat development, or recreational land maintenance.

Key components of integrated weed management program include:

- Preventing encroachment into non-infested sites;
- Detecting and eradicating new introductions;
- Eradicating small populations within or adjacent to high valued areas (such as wilderness, sensitive plants, and key wildlife habitat);
- Containing large weed populations;
- Re-vegetating when necessary; and
- Properly managing competitive vegetation

A successful program consists of a sustained effort, constant evaluation, and adoption of improved strategies as they arise.

The goals of implementing the various elements of integrated weed management are to:
- Increase public awareness regarding impacts of noxious weeds to resource values;
- Limit weed seed dispersal from roads and trails:
- Contain neighboring weed infestations; and
- Minimize soil disturbance.

Forest management practices already utilize measures such as the washing of machinery to prevent further spread of noxious or invasive weeds. Prevention efforts also include a Special Order that requires certified weed seed-free feed to be used on all National Forest and Bureau of Land Management Lands in the States of Montana and South Dakota. Educational efforts include distribution of posters or other informational visual materials, as well as other available opportunities. Efforts need to continue in these areas to increase awareness of the weed problem in this area and personal commitments to minimizing the spread of these weeds.

Mechanical and cultural control of noxious weeds has not been very effective at containing or reducing widespread existing infestations. For example, roadside mowing has not prevented spotted knapweed from flowering and going to seed. Hand pulling, the principal method of mechanical control used on the CNF, has been effective on individual plants or very small, isolated weed populations. However, attempts to hand-pull large infestations of weeds have provided only temporary control because seeds remain viable in the soil for many years and the act of pulling up the weed often creates an ideal site for seeds to sprout in. This method is completely ineffective on deep-rooted weeds such as leafy spurge, and weeds that reproduce through runners or shoots, such as St. Johnswort, yellow toadflax, and Canada thistle. Tilling and burning infestations have had limited effectiveness and usually needs herbicide treatment as well (see Appendix F).

Herbicide applications have been used on the CNF with good success. However, these have been utilized up to this point only in areas authorized by the 1987 Noxious Weed Management Projects decisions or subsequent tiered decisions. New herbicides are now available and were not addressed in the 1987 Custer NF Noxious Weed EIS.

Biological control agents are chosen for their host specificity (i.e., they are designed to target only a particular weed species). In this sense they are useful in native plant communities because they avoid other non-target vegetation. Biological control agents can include the use of insects or pathogens to consume or kill select portions of individual weeds, reducing growth or reproduction of the weed. Seven biological control flea beetle releases (*Aphthona nigriscutis)* on leafy spurge have been done on the Sioux and Ashland Ranger Districts at various times between 1993 and 2002. Some effectiveness of these releases has been observed.

Preventing introduction and spread of weeds is one objective of the integrated weed management program on the Forest. Best management practices are outlined in Forest Service policy (Northern Region 2001 2080 directives supplement) and the comprehensive Guide to Noxious Weed Prevention Practices (USDA FS 2001) (see Appendix D). These guides are for use in planning resource management activities and operations. The guides assists manger and cooperators in identifying weed prevention practices that mitigate identified risks of weed introduction and spread for projects and programs. Factors critical in a prevention program include:
- Limiting weed seed dispersal occurring from vehicles and equipment traveling forest roads, and people and livestock traveling forest trails;
- Containing neighboring weed infestations;
- Minimizing soil disturbance;
- Detecting and eradicating newly established weeds;
- Establishing competitive desirable vegetation; and
- Managing forage, including re-vegetation and shade management.

In addition, the Forest depends on public education and weed prevention programs to deter establishment of new weed species. Weed education programs have helped raise public awareness about invasive weeds and what steps can be taken to help reduce the spread of existing weeds and establishment of new invaders.

Prevention measures that minimize establishment and spread of noxious weeds are already a part of Forest Service policy and recent decisions, and therefore will not be repeated in this analysis. The CNF fully utilizes prevention, education, and non-chemical activities to combat weeds on the forest. Herbicide, mechanical, and biological methods as addressed in this analysis would be used in conjunction with these other activities where necessary or appropriate.

COMPARISON OF WEED MANAGEMENT METHODS

Table 1 - 2 compares the relative limitations, management effectiveness, and approximate costs of the weed management methods used in the analysis.

TABLE 1 - 2. LIMITATIONS, EFFECTIVENESS AND COSTS BY METHOD [3]

Methods	Limitations	Management Effectiveness[1]	Approximate Implementation Cost/Acre
CULTURAL			
Seeding	Environmental limitations; cannot be conducted on steep, remote, rocky sites; causes ground disturbance which may increase likelihood of re-invasion; most effective after weed populations have been reduced by other control actions.	Not able to estimate	$100 to $300 Average $250
Grazing	Treatment must occur during proper phenological stage; herding required; sometimes nonselective; can reduce forage available for big game; predator predation problems; disease transfer to bighorn sheep	Low cost/low effectiveness	$50
MECHANICAL			
Hand pulling/ Grubbing	Labor intensive; not effective on deep-rooted or rhizomatous perennial; causes ground disturbance which may increase susceptibility of site; effective on single plants or small low-density infestations.	High cost/ low effectiveness	$400
Mowing	Limited to smooth gentle slope; treatment timing critical; impact on non-target vegetation	Low cost / low effectiveness	$200
Tilling	Limited to smooth gentle slopes, impact on non-target vegetation.	Low cost / low effectiveness	$200
Prescribed Burning	Climate limitations; may increase likelihood of re-invasion unless combined with other treatment methods.	Low cost / low effectiveness	$40
BIOLOGICAL			
Parasites, Predators and Pathogens	Does not achieve eradication; effective only on one species, only a few weeds with available agent; most agents not effective by themselves need multiple agents	Moderate cost/ moderate effectiveness	$150
HERBICIDES			
Ground Application	Not cost effective on slopes greater than 40 percent; must have accessible sites; potential impacts to non-target vegetation; application timing limited based on plant phenology and weather conditions.	Low cost/ moderate to high effectiveness	$30 –Vehicle, $125 –Backpack, $50 – ATV, $300 – Horse Average $100
Aerial Applications	Potential impacts to non-target resources; application timing limited based on plant phenology and weather conditions.	Low cost/ moderate to high effectiveness	$40
WEED PREVENTION			
All Methods	Not effective on existing infestations; ineffective if not enforced	Not measurable	

Notes: [1]Percent of target species killed in a treatment area: High = 75 to 100 percent; Moderate = 46 to 75 percent; Low = 25 to 45 percent; Very Low = 0 to 24 percent.
Not measurable – means the cost/effectiveness is not measurable or quantifiable.

[3] USDA, FS, 2005

A successful program consists of a sustained effort, constant evaluation, and adoption of improved strategies as they arise.

The goals of implementing the various elements of integrated weed management are to:

- Increase public awareness regarding impacts of noxious weeds to resource values;
- Limit weed seed dispersal from roads and trails:
- Contain neighboring weed infestations; and
- Minimize soil disturbance.

Forest management practices already utilize measures such as the washing of machinery to prevent further spread of noxious or invasive weeds. Prevention efforts also include a Special Order that requires certified weed seed-free feed to be used on all National Forest and Bureau of Land Management Lands in the States of Montana and South Dakota. Educational efforts include distribution of posters or other informational visual materials, as well as other available opportunities. Efforts need to continue in these areas to increase awareness of the weed problem in this area and personal commitments to minimizing the spread of these weeds.

Mechanical and cultural control of noxious weeds has not been very effective at containing or reducing widespread existing infestations. For example, roadside mowing has not prevented spotted knapweed from flowering and going to seed. Hand pulling, the principal method of mechanical control used on the CNF, has been effective on individual plants or very small, isolated weed populations. However, attempts to hand-pull large infestations of weeds have provided only temporary control because seeds remain viable in the soil for many years and the act of pulling up the weed often creates an ideal site for seeds to sprout in. This method is completely ineffective on deep-rooted weeds such as leafy spurge, and weeds that reproduce through runners or shoots, such as St. Johnswort, yellow toadflax, and Canada thistle. Tilling and burning infestations have had limited effectiveness and usually needs herbicide treatment as well (see Appendix F).

Herbicide applications have been used on the CNF with good success. However, these have been utilized up to this point only in areas authorized by the 1987 Noxious Weed Management Projects decisions or subsequent tiered decisions. New herbicides are now available and were not addressed in the 1987 Custer NF Noxious Weed EIS.

Biological control agents are chosen for their host specificity (i.e., they are designed to target only a particular weed species). In this sense they are useful in native plant communities because they avoid other non-target vegetation. Biological control agents can include the use of insects or pathogens to consume or kill select portions of individual weeds, reducing growth or reproduction of the weed. Seven biological control flea beetle releases (*Aphthona nigriscutis)* on leafy spurge have been done on the Sioux and Ashland Ranger Districts at various times between 1993 and 2002. Some effectiveness of these releases has been observed.

Preventing introduction and spread of weeds is one objective of the integrated weed management program on the Forest. Best management practices are outlined in Forest Service policy (Northern Region 2001 2080 directives supplement) and the comprehensive Guide to Noxious Weed Prevention Practices (USDA FS 2001) (see Appendix D). These guides are for use in planning resource management activities and operations. The guides assists manger and cooperators in identifying weed prevention practices that mitigate identified risks of weed introduction and spread for projects and programs. Factors critical in a prevention program include:

- Limiting weed seed dispersal occurring from vehicles and equipment traveling forest roads, and people and livestock traveling forest trails;
- Containing neighboring weed infestations;
- Minimizing soil disturbance;
- Detecting and eradicating newly established weeds;
- Establishing competitive desirable vegetation; and
- Managing forage, including re-vegetation and shade management.

In addition, the Forest depends on public education and weed prevention programs to deter establishment of new weed species. Weed education programs have helped raise public awareness about invasive weeds and what steps can be taken to help reduce the spread of existing weeds and establishment of new invaders.

Prevention measures that minimize establishment and spread of noxious weeds are already a part of Forest Service policy and recent decisions, and therefore will not be repeated in this analysis. The CNF fully utilizes prevention, education, and non-chemical activities to combat weeds on the forest. Herbicide, mechanical, and biological methods as addressed in this analysis would be used in conjunction with these other activities where necessary or appropriate.

COMPARISON OF WEED MANAGEMENT METHODS

Table 1 - 2 compares the relative limitations, management effectiveness, and approximate costs of the weed management methods used in the analysis.

TABLE 1 - 2. LIMITATIONS, EFFECTIVENESS AND COSTS BY METHOD [3]

Methods	Limitations	Management Effectiveness[1]	Approximate Implementation Cost/Acre
CULTURAL			
Seeding	Environmental limitations; cannot be conducted on steep, remote, rocky sites; causes ground disturbance which may increase likelihood of re-invasion; most effective after weed populations have been reduced by other control actions.	Not able to estimate	$100 to $300 Average $250
Grazing	Treatment must occur during proper phenological stage; herding required; sometimes nonselective; can reduce forage available for big game; predator predation problems; disease transfer to bighorn sheep	Low cost/low effectiveness	$50
MECHANICAL			
Hand pulling/ Grubbing	Labor intensive; not effective on deep-rooted or rhizomatous perennial; causes ground disturbance which may increase susceptibility of site; effective on single plants or small low-density infestations.	High cost/ low effectiveness	$400
Mowing	Limited to smooth gentle slope; treatment timing critical; impact on non-target vegetation	Low cost / low effectiveness	$200
Tilling	Limited to smooth gentle slopes, impact on non-target vegetation.	Low cost / low effectiveness	$200
Prescribed Burning	Climate limitations; may increase likelihood of re-invasion unless combined with other treatment methods.	Low cost / low effectiveness	$40
BIOLOGICAL			
Parasites, Predators and Pathogens	Does not achieve eradication; effective only on one species, only a few weeds with available agent; most agents not effective by themselves need multiple agents	Moderate cost/ moderate effectiveness	$150
HERBICIDES			
Ground Application	Not cost effective on slopes greater than 40 percent; must have accessible sites; potential impacts to non-target vegetation; application timing limited based on plant phenology and weather conditions.	Low cost/ moderate to high effectiveness	$30 –Vehicle, $125 –Backpack, $50 – ATV, $300 – Horse Average $100
Aerial Applications	Potential impacts to non-target resources; application timing limited based on plant phenology and weather conditions.	Low cost/ moderate to high effectiveness	$40
WEED PREVENTION			
All Methods	Not effective on existing infestations; ineffective if not enforced	Not measurable	

Notes: [1]Percent of target species killed in a treatment area: High = 75 to 100 percent; Moderate = 46 to 75 percent; Low = 25 to 45 percent; Very Low = 0 to 24 percent.
Not measurable – means the cost/effectiveness is not measurable or quantifiable.

[3] USDA, FS, 2005

Purpose 2: Maintain forest, non-forest, and riparian ecosystem integrity and health by using an Integrated Pest Management approach by:

- limiting the spread of "widespread invader" species on the CNF or onto adjacent lands, and reducing invader populations where possible;
- containing "new invader" species that already occur on the CNF, with strong emphasis on reducing their populations;
- containing or eradicating any "potential invader" species that may appear on the CNF; and
- continuing monitoring for undesirable plant populations.

Need: Additional control measures and emphasis are needed to limit the further presence and impacts of these weed species on ecosystem integrity.

Weed infestations can cause substantial habitat loss as well as negatively affect diversity of plant communities and habitat function. Our current inability to treat some infestations leads to a continual and compounding annual loss of desired habitat to weeds and creates the potential to infest adjacent lands or defeat existing control efforts by neighboring landowners. This is inconsistent with Forest Plan and Northern Region goals for sustaining native plant diversity and desired community function. There is also a need to protect sensitive and unique habitats (including A-B Wilderness Area, Research Natural Areas, wetlands, sensitive plant populations, and big game winter range).

The Northern Region Overview identified weeds as the greatest risk to grass and shrub lands on National Forest. New, safer target-specific herbicides and biological controls are now available that were not considered in previous decisions. These new controls can be more effective while reducing impacts to humans and non-target species. Aerial application and authorization of new herbicides and biocontrols can increase the effectiveness of the CNF weed control program.

Current weed management activities on the CNF already combine prevention and education with biological, mechanical, and cultural control applications, with very limited use of herbicide applications, in an overall IPM strategy. However, these combined efforts, with minimal use of herbicides, have not been sufficient to contain, control, or reduce existing or new populations of noxious and invasive weeds.

Populations of "widespread invader" (Category 1) weeds continue to rapidly expand on the CNF. Leafy spurge, spotted knapweed, houndstongue, and Canada thistle are examples of these weeds and are present on all three ranger districts of the CNF. Since initial establishment on the CNF (in many cases, decades ago), weeds in this category have steadily, and in some cases rapidly, increased along Forest roads and in other disturbed areas such as trailheads, campgrounds, gravel pits, and power lines.

Salt cedar and purple loosestrife are examples of "new invaders" (Category 2) species that have only recently become established on or near the CNF. These species are only known from a few localities. Some were first seen on CNF lands as recently as the 1990's, while others have been around longer, yet have only recently been discovered on CNF lands. Most of the other new invaders are currently very restricted in their distribution.

Common crupina is an example of a "potential invader" (Category 3) species. These types of species have not yet been documented in the states or may be found only in small, scattered, localized infestations. Based on the extent of infestations in nearby states, these weeds have the potential to become widespread and cause severe economic and environmental effects. Common crupina has been noted on the South Dakota portion of the Sioux Ranger District.

It has also become apparent that damage to forest resources from noxious weeds is increasing due to their expanding populations. Because they are non-native in origin, noxious weeds may often out-compete native plants due to a lack of naturally adapted competitors or biological control agents. Noxious weeds may crowd out native plants and diminish the productivity and ecosystem integrity, biodiversity, and appearance of National Forest lands.

ECOLOGICAL IMPACTS OF INVASIVE PLANTS

Invasive plants can alter the structure, organization and function of ecological systems including soil, plants, and animal relationships (USDA FS, 2005). Spotted knapweed dominance on many open timber and grassland communities on the Forest may be affecting soil properties such as microbial activity, nutrients and moisture, as well as increasing soil erosion. Native plant composition, diversity, species richness, and litter production are also affected. Changes in plant communities from native to non-native species impact wildlife species that depend on open timber and grassland for forage, and breeding and nesting habitat. Spotted knapweed is prevalent throughout the Forest and extensive research on this species has revealed numerous ecological impacts associated with its presence. A resent study has proven that spotted knapweed releases a phytotoxic chemical that inhibits the growth of Idaho fescue thus giving a competitive advantage to spotted knapweed (Goodwin and Sheley, 2003). Other noxious weed species are expected to result in similar impacts to ecosystem processes. Examples of ecological impacts from spotted knapweed will dominate the discussion in this section, but this does not preclude the impacts caused by the presence other species.

Soil: Invasive plants can affect the structure of ecosystems by altering soil properties. Soil in areas dominated by invasive plants may have lower amounts of organic matter and available nitrogen than areas supporting native grasslands. Organic matter can be affected in various ways. For example, spotted knapweed has a deep taproot, which tends to decompose more slowly than the fine roots of native grasses, reducing the annual input of organic matter into the soil. Biologically active organic matter occurs within the top one to four inches of soil and may be more prone to loss even during minor run-off events. A study conducted by Montana State University found that runoff and sediment yield increase 56 percent and 192 percent, respectively, on spotted knapweed sites compared to sites dominated by native bunchgrass (Tu et al., 2001).

Soil nutrient levels may be affected by the presence of invasive species. For example, potassium, nitrogen, and phosphorous levels were 44 percent, 62 percent and 88 percent lower on soil from a spotted knapweed-infested site than from adjacent soil with a grass overstory in a study conducted by Harvey and Nowierski (Tu et al., 2001). Plants that reduce soil nutrient availability to very low levels have a competitive advantage over neighboring plants (Tu et al., 2001).

Soil microorganisms can either benefit or be impacted by the presence of secondary compounds produced by some weedy species. Most microbial populations adapt to secondary compounds by increasing their populations, thereby increasing the rate of breakdown of secondary compounds. Conversely, these secondary compounds may limit activity and growth of aerobic soil microbial populations, resulting in thick liter layers and slower nutrient cycling (Tu et al., 2001).

Soil moisture can also be altered by the presence of tap-rooted weedy species. Tap-rooted forbs may reduce infiltration because they do not have dense, fine root systems of grasses, which contribute organic matter and enhance soil structure. Infested sites may also have more extreme temperature changes because of lower soil water content; poorer soil aggregation; and greater exposure of soil to direct sunlight (Tu et al., 2001). Water has a high capacity to store heat. By reducing soil water content in surface soil, greater evaporation enhances rapid heating and cooling of near-surface layers. This will increase runoff by lowering infiltration, again reducing thermal conductivity and capacity of the soil to store heat resulting in greater temperature extremes at the soil surface (Tu et al., 2001).

Native Plant Communities: Invasive plants have a variety of mechanisms giving them a competitive advantage over native species. For example: invasive plants can be alleopathic (contain compounds that suppress other plants); produce abundant seed; establish and spread in a wide range of habitats; grow rapidly; initiate growth earlier in the season and later in the season; exploit water and nutrients better; have no native enemies; and are not palatable to large herbivores. Once established, non-native plants threaten biological diversity of native plant communities and can alter ecosystem processes.

As mentioned above spotted knapweed is prevalent throughout the Custer National Forest. It occurs primarily on roadsides, on grasslands and open forest community types. Invasion of knapweed into disturbed and undisturbed native bunchgrass communities is well documented (Stannard, 1993;

DiTomaso, 1999; Tu et al., 2001). As spotted knapweed and other invasive plants increase, cover of more desirable but less competitive grasses and forbs is significantly reduced, sometimes as much as 60 to 90 percent (Maxwell et al., 1992; Beck, 1994). A study conducted in Glacier National Park reported that spotted knapweed reduced the number and frequency of native species. In addition, seven species classified as "rare" and "uncommon" at the beginning of the study were not present three years later. These results suggested that spotted knapweed alters plant community composition (Tyser et al., 1998).

Rare plants are particularly vulnerable to invasive plants (DiTomaso, 1999). Beartooth goldenweed is endemic to the Bighorn Basin and is listed as sensitive on the Beartooth Ranger District by the Forest Service. It is an example on the CNF where a population is at risk because of encroachment of habitat by spotted knapweed.

Cryptogramic ground crust may also be impacted by invasive weeds. This crust, which is composed of small lichens and mosses and commonly covers undisturbed soil surfaces, is important for soil stabilization, moisture retention and nitrogen fixation (Parks et al., 2004). Tyser (Tyser et al., 1998) compared a native fescue grassland site to one invaded by spotted knapweed in Glacier National Park. Study results indicated that the cryptogramic ground cover within spotted knapweed infested sites was 96 percent less than native fescue grassland site.

Wildlife Habitat: The introduction of exotic plants influences wildlife by displacing forage species, modifying habitat structure (such as changing grassland to a forb-dominated community), or changing species interactions within the ecosystem (DiTomaso; 1999). Exotic plants on the Custer Forest have started to invade important big game winter ranges, reducing forage available for over-wintering animals. On the Lolo National Forest, forage availability was identified as the most limiting factor for over-wintering elk and deer populations. Forage that is low in nutrients also hinders elk and deer because they metabolize fat at an accelerated rate to stay warm in colder temperatures.

Unlike elk and deer, bighorn sheep are relatively non-migratory. They spend most of the year on low elevation big game winter ranges, which are often associated with talus slopes. Additional demands are placed on the forage base because they are non-migratory and forage yearlong on some ranges. Bighorn sheep yearlong foraging makes them more dependent on high quality forage on low elevation big game winter ranges than elk and deer.

A 1996 study conducted by Thompson (Laugenberg et al., 2005) on the Three-Mile Wildlife Management Area suggested that elk are not obligate grazers and may lose foraging efficiency where knapweed dominates native ranges. Although elk can incorporate spotted knapweed into their diets, they have been observed using areas with a low relative abundance of knapweed more frequently than infested areas. Thompson (Laugenberg et al., 2005) concluded that management practices affecting vegetation on winter ranges are likely to have profound impacts on ungulate foraging efficiency during the season when energy balance is especially critical.

Elk migration patterns may be altered due to the presence and dominance of spotted knapweed (Laugenberg et al., 2005). In general, use of spotted knapweed by wildlife and livestock is highest during the spring and early summer when plants are green and actively growing in the rosette and bolt stages. Spotted knapweed can have about 18 percent crude protein early in the season, but nutritional value decreases and fiber content increases later in the season. Although spotted knapweed infestations are considered more detrimental to elk than deer, the plant was not detected in mule deer diet even though it was common on winter ranges (USDA, FS, 2005).

Spotted knapweed is not considered food forage, even though the plants can contain high amounts of crude protein. The bitter-tasting compounds primarily found in the leaves reduce palatability. Even though animals may ingest spotted knapweed, the secondary compounds in the forage may affect rumen microbial activity thereby reducing forage intake, or may cause general malaise resulting in aversive post-ingestive feedback (USDA, FS, 2005).

Humans: Spotted knapweed has direct and indirect effects on humans. Beekeepers value spotted knapweed because of the quality of honey produced from its flowers. However, the flowers are also pollen sources, which produce positive allergic skin tests and are a significant allergen causing allergic reactions

(USDA, FS, 2005). People residing in knapweed-infested areas are treated for a variety of knapweed allergies ranging from skin hives to knapweed-induced asthma attacks. Some individuals are required to carry artificial adrenalin kits and take weekly allergy shots (USDA, FS, 2005).

Purpose 3: Comply with the 1987 Custer Forest Plan, which incorporates Federal and State laws regulating management of noxious weeds.

Need: The CNF needs to comply with Federal and State direction and regulations by expanding the weed management plan.

The Forest is directed by law, regulation, and agency policy to treat weeds. The following laws give broad authority for control of weeds on National Forest System land, and several laws and regulations specifically provide for control of such weeds.

Custer National Forest Plan. The 1987 Custer National Forest Plan (FP) directs control of noxious weeds as a priority item (FP Page II-3) where the goal is to implement an "integrated pest management program aimed at controlling new starts, priority areas of minor infestations. Holding actions will be implemented on areas of existing large infestations." The Forest Plan also directs that noxious weed control program be developed for the Absaroka-Beartooth Wilderness Area in order to maintain wilderness values (FP Appendix II, p. 156).

Existing Weed Control Plans. 1987 Records of Decision and the 1987 Decision Notice for the West Fork of Rock Creek (Beartooth District) are in place for the control of weeds on each district of the CNF. Additional decisions that tier to these documents have also been made for specific projects such as road and trail construction, oil and gas leasing, timber sales, grazing management and special uses.

Executive Order (03 February 1999) directs Federal Agencies to prevent and control invasive species.

Executive Order 13112, signed by the President of the United States in February 1999, directs federal agencies to conduct activities that will reduce noxious weed populations.

The Federal Noxious Weed Act of 1974 (PL 93-629) authorizes the Secretary of Agriculture to cooperate with other agencies to control and prevent noxious weeds.

The South Dakota CL 38.22 provides for designation of noxious weeds in the State, direction of control efforts, registration of pesticides and licensing of applicators, and enforcement of statutes. The law delegates enforcement to County Commissioners.

The Montana Noxious Weed Law 1948, amended in 1991 provides for designation of noxious weeds in the State, direction of control efforts, registration of pesticides and licensing of applicators, and enforcement of statutes. The law delegates enforcement to County Commissioners.

The Montana County Noxious Weed Management Act defines a noxious weed as "any exotic plant species established, or that may be introduced in the state, which may render land unsuitable for agriculture, forestry, livestock, wildlife, or other beneficial uses and is further designated as either a state-wide or county-wide noxious weed" (7-22-2101 MCA). In addition, this act states that it is unlawful for any individual to allow noxious weeds to propagate or go to seed on their land unless they are complying with an approved weed management plan.

Carlson-Foley Act of 1968 (PL 90-583) directs Federal Agencies to permit control of noxious weeds on Federal lands, by State and local governments on a re-imbursement basis.

36 CFR 222.8 directs the Forest Service to cooperate with local weed control Districts to analyze and develop noxious weed control programs.

Federal Noxious Weed Act of 1974 (sec 9) authorized the Secretary to cooperate with other Federal and State agencies or political subdivisions thereof, and individuals in carrying out measures to eradicate, suppress, control or prevent the spread of noxious weeds.

Forest Service Manual 2259.03 directs Forest officers to control noxious weeds on National Forest System lands, and cooperate fully with State, County and Federal officials in implementing 36 CFR 222.8 and the Carlson-Foley Act.

The Federal Land Policy Management Act of 1976 (PL 94-579) authorizes control of weeds on rangeland.

The National Forest Management Act of 1976 (PL-94-588) authorizes removal of deleterious plant growth.

The Wilderness Act of 1964; Amended October, 1978: The Absaroka-Beartooth Wilderness Area was established in 1978. The goal of Wilderness Areas is to retain its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions.

Purpose 4: Cooperate with other agencies and private individuals concerned with the management of noxious weeds.

Need: Without an adequate plan for weed control on lands managed by the CNF, efforts on other lands and the management plan for the individual counties are greatly hampered.

The CNF manages land in Carbon, Stillwater, Sweet Grass, Park, Powder River, Carter, and Harding Counties, and to varying degrees, non-Forest Service lands in these counties are often adjacent to or intermingled with CNF-managed lands. The general public continues to demand increased noxious weed control efforts on local, state, and federal lands in those counties, including lands managed by the CNF. Many agencies in these counties have implemented Memorandums of Understanding with county weed districts. The Custer National Forest is also pursuing coordinated Weed Management Area efforts with various counties. However, due to existing noxious weeds, along with the threat of new and potential invader plants, local efforts must continue to expand.

The Greater Yellowstone Coordinating Committee identified management of noxious weeds as one of the highest priority needs in the Greater Yellowstone Area. The Absaroka–Beartooth Wilderness tri-Forest committee has also identified the management of noxious weeds as one of the highest priority needs in the A-B Wilderness Area.

Vehicle traffic, livestock, wildlife, wind, and contaminated gravel, straw, and hay readily move noxious weeds between the CNF and other lands. Many adjacent landowners control noxious weeds on their property. A partnership approach is vital to a successful control program.

PROPOSED ACTION

The Forest is proposing to broaden the 1987 Environmental Analysis for control of weeds to:

- Permit the use of different types of EPA registered herbicides;
- Allow use of herbicides within the Absaroka-Beartooth Wilderness Area.
- Treat approximately 1,500 net acres (within approximately 14,000 managed gross acres) with a combination of treatment methods such as ground-based and aerial application of herbicides, biological control agents, grazing, mechanical and cultural (the actual amount of annual treatment will depend on available funding and monitoring results);
- Treat additional new infestations through adaptive management tools for assessing new treatments and new sites;
- Broaden control methods to include the use of aerial application; and
- Broaden protection measures for ground and aerial applications.

The Proposed Action (Alternative 1) is further described in Chapter 2 regarding specific treatment sites, size of treatment, targeted species, and treatment methods.

SCOPE OF THE ANALYSIS

The scope of this analysis is limited to the effects of weeds, and weed control treatments (as proposed in Alternative 1) on different resources within the Custer National Forest boundary.

Impacts

Regulations contained in 40 CFR 1508.25(c) require analysis of direct, indirect, and cumulative impacts. Direct effects are caused by the action and occur at the same time and place as the Proposed Action. Indirect effects are caused by the action and occur later in time or farther removed in distance, but are still reasonably foreseeable. Cumulative impacts are those impacts on the environment that result from incremental impact of the action where added to other past, present, and reasonably foreseeable future action.

Alternatives

In determining the scope of analysis, the agency must consider three types of alternatives (40 CFR 1508.25[b]): no action alternative, other reasonable courses of action, and protection measures. Chapter 2 presents a range of alternatives for site-specific treatment of invasive weeds. Alternatives that have a reasonable likelihood of partial success are discussed in detail. Protection measures for each alternative have been developed by the Forest and outlined Chapter 2 and Appendix C. Impacts of the no-action alternative, which would maintain the current program projects on the forest, are also considered.

Connected, Cumulative and Similar Actions

Regulations in Code of Federal Regulations (CFR) Title 40 1508.25 address the scope of analysis and elements to be considered in a proposed action. The regulations recognize that separate activities can combine and interact to create impacts that may be significantly beyond the effects of individual actions. These actions are considered cumulative, and their additive effects are addressed in Chapter 4.

Federal regulations also require a combined analysis of connected actions. Connected actions are those that are closely related and 1) automatically trigger other actions, 2) could not or would not proceed unless other actions are taken previously or simultaneously, and 3) are interdependent parts of a larger action and depend on the larger action for their justification. The effects of connected actions are analyzed together. Similar actions are those that share a common timing or geography and therefore can be evaluated together.

SCOPE OF THE PROPOSED ACTION

This environmental assessment is the documentation of site-specific effects of the proposed action and the no-action alternative. It is not a general management plan or a programmatic environmental analysis. No further decisions would be made under the National Environmental Policy Act prior to implementation of the selected alternative.

The proposed action would not supercede either the 1987 Noxious Weed Management Record of Decisions (RODs) or the 1987 West Fork of Rock Creek Decision Notice. Rather, this proposal would be a "companion" analysis and decision that would enable the CNF to use new herbicides and to implement treatment of additional weed infestations not analyzed by those projects.

Geographic Scope. The geographic scope of this analysis is confined to the treatment areas that would occur within the Custer National Forest boundary. The scope of the proposed action is limited to the management activities as described in Chapter 2. Activities could occur in all management areas described in the CNF Forest Plan. Descriptions of the goals and objectives of these management areas

are described in Chapter III of the Forest Plan. The proposal includes undesirable weed treatments only on lands managed by the CNF, including Wilderness and roadless areas.

For each resource issue an analysis area was determined that could be used to adequately measure cumulative effects of the proposed alternatives. Unless otherwise stated, the cumulative effects area is the same as the project area.

Temporal Scope. The timeframe for project implementation is estimated for up to 15 years. Direct, indirect, and cumulative effects, if any, would occur during that period. For cumulative effects analysis, an additional 10 years past the final implementation year is included in the analysis. In some cases, longer-term effects are also discussed.

DECISION TO BE MADE

The Forest Supervisor of the Custer National Forest is the Responsible Official for making the decision concerning this proposal. Given the purpose and need, the deciding official reviews the proposed action, the other alternatives, and the environmental consequences in order to make the following decisions:

- Whether to expand current efforts to control weeds
- What treatment methods would be used;
- What herbicides would be used;
- What protection measures and monitoring measures would be required; and whether to include an adaptive approach to address future spread of invasive weeds. If authorized, the decision would describe adaptive management options under specific settings and conditions.

The EIS is a project level analysis. The scope of the project is confined to issues and potential environmental consequences relevant to the decision. This analysis does not attempt to re-evaluate or alter decisions made at higher levels. The decision is subjected to and would implement direction from higher levels.

National, regional, policies, and Forest Plan rules direction require consideration of effects of all projects on weed spread and prescribe protection measures where practical to limit those effects. Reconsideration of other existing project level decisions or programmatically prescribing protection measures or standards for future Forest management activities (such as travel management, timber harvest, and grazing management) are beyond the scope of this document. Cumulative effects of the Project are addressed where appropriate in Chapter 4, combined with effects of other Forest activities.

Even with careful consideration, unforeseen events can occur that will require additional analyses. Unanticipated events can result in new information that could have a bearing on a decision. Forest Service procedures for addressing these new information, documents, and decisions are thoroughly explained in FSH 1909.15, Section 18.

DECISIONS THAT WILL NOT BE MADE

Decisions that will not be made based on this analysis are briefly discussed below:

- Changes in land use and Forest management objectives.
- Changes in the level of wildland fire suppression, strategies and tactics, and decisions on whether or not to control wildfire.
- Changes in travel, road use and access
- Roads analysis or road management decisions will not be addressed in this analysis, but will be addressed at a later date per FSM 7710. The Deciding Officials determined that the scope and scale of issues under consideration do not warrant a roads analysis. There are no proposed road

management activities (road construction, reconstruction, and decommissioning) that would result in changes in access, such as changes in current use, traffic patterns, and road standards (FSM 7712.13c).

- Prevention measures that minimize establishment and spread of noxious weeds are already a part of Forest Service policy and recent decisions and therefore will not be repeated in this analysis (see Appendix D). The CNF fully utilizes prevention, education, and non-chemical activities to combat weeds on the forest. Herbicide, mechanical, and biological methods as addressed in this analysis would be used in conjunction with these other activities where necessary or appropriate. The following outline recent prevention and education decisions, policy, and measures for the weed control program occurring within the analysis area:

    - Forest Service Policy (FSM 2080 R1 Supplement 2000-2001-1) provides Best Management Practices (BMPs) for Weed Control (see Appendix D). They specify incorporation of weed prevention and control through project layout, design, and alternative evaluation and project decisions to reduce potential sites for weed establishment.
    - Coordination of weed prevention and control efforts continues at the local, County, State, regional, and national levels.
    - The Weed Seed Free Feed and Straw program is a Forest and Region-wide requirement. This program requires all hay, straw and processed feeds entering the Forest to be certified free of weed seed. The certification program is controlled by the Montana and South Dakota State Departments of Agriculture and relies on a field survey of crops prior to harvest.
    - The Off Highway Vehicle (OHV) amendment for Region One was implemented in January 2001. Off road or trail use by OHVs is restricted and will reduce one vector of weed spread. The first year focused on public education of riders in the field. In 2002 the enforcement phase of the amendment will result in citations instead of warnings.
    - Timber sales and other activities utilizing mechanical equipment commonly include, and will continue to include, the requirement that off-road equipment be washed prior to entering sites on the CNF (see Appendix D).
    - Each Ranger District Office and the Supervisor's Office have a wide array of information available on noxious weed identification, prevention, and control. In addition, the major trailheads into the Wilderness areas on the CNF are posted with informational brochures and the requirement to use only certified noxious weed seed-free feed for livestock.
    - Field employees on the CNF will continue to be trained in identification of noxious weeds.

CHAPTER 2

PUBLIC PARTICIPATION, ISSUES, AND ALTERNATIVES

INTRODUCTION

This chapter provides information on how the public was involved in providing comment on this Project, how the alternatives were developed, and a description of how issues and alternatives were addressed in this document. This is followed with a description of the four alternatives that are studied throughout the document, a description of adaptive management, a brief economic comparison of the alternatives, and a list of protection measures. A summary comparison and maps of the three alternatives can be found at the end of the chapter.

PUBLIC PARTICIPATION

Public participation helps the Forest Service identify concerns with possible effects of its proposals. It is also a means of disclosing to the public the nature and probable consequences of actions on National Forest land.

A public involvement strategy for this project was developed to ensure that potentially interested members of the public and other government agencies received timely information about the proposal in order to be able to fully participate in the planning process. A copy of this strategy is located in the project record. During its duration, the project was also listed in each Custer National Forest (CNF) quarterly Notice of the Schedule for NEPA projects.

In order to help identify specific areas of concern, a scoping document was sent to on November 19, 2001 to 360 individuals, government agencies, tribal interests, news media, businesses, and organizations that have shown interest in similar projects on the CNF. This document provided information on the purpose and need for the project, described the proposed action, and asked for comments. People were asked to comment in 30 days, which period ended on December 31, 2001. The scoping document and mailing list are included in the project file.

A legal advertisement inviting comments was placed in The Billings Gazette (Billings, MT) and the Rapid City Journal (Rapid City, SD) in November 2001, summarizing the information provided in the letter. News releases were sent to local newspapers, as well. These media efforts helped to publicize the proposal and comment period.

In response to these efforts, nine letters, personal comments, or phone calls were received. Review of the public's responses showed that all respondents were in agreement that noxious and invasive weeds are of urgent concern on the CNF and surrounding areas and those steps should be taken to reduce or eliminate their presence on the CNF. Of these, all but one supported the use of herbicides as part of the proposal, although some had questions or comments concerning the effects of the herbicides. The remaining one commenter either questioned the need for using herbicides or was concerned about the environmental effects of using herbicides. All comments were considered by the ID team and responsible official, and are documented in the project file.

On August 18, 2006, the Notice of Availability was published in the Federal Register. This officially started the 45-day comment period for the Draft EIS. A legal notice was published in Billings Gazette and Rapid City Journal on August 21, 2006 and August 22, 2006, respectively. On August 22, 2006 a news release was mailed to 14 newspapers[1]. Copies of the Draft EIS were mailed to 11 agencies and 23 individuals[2]. Five comments were received. Chapter 6 outlines the comments and Forest Service responses.

---

[1] News Releases sent to Stillwater Co. News, Carbon Co. News, Lovell Chronicle, Billings Gazette, The Outlook, The Outpost, Yellowstone Co. News, Miles City Star, Powder River Examiner, Nation News, Bowman Co. Pioneer, Rapid City Journal, Independent Press, The Ekalaka Eagle Newspapers

ALTERNATIVE DEVELOPMENT PROCESS

Comments from the public and from the Custer National Forest resource specialists were used to determine potential issues which were then categorized according to relevance to the purpose and need. The categories included significant issues as well as issues deemed to be beyond the scope of the purpose and need for this project. Also included are those suggestions for protection measures, monitoring recommendations, and alternatives. Significant issues were used to develop alternatives to the proposed action. Issues that were considered outside the scope of the EIS are described in this chapter, along with alternatives that were dismissed from detailed analysis. Protection measures are outlined in Appendix C and monitoring aspects are listed near the end of this chapter.

The issues that drove the development of different alternatives include the concern of potential impacts of herbicide on human health, wildlife and aquatic resources, and the impact of aerial application potential drift on non-target areas and species. In response to these issues, three alternatives were developed: Alternative 1 - Proposed Action Alternative (Integrated Pest Management, including the use of both ground and aerial application of herbicide, herbicide use within the Absaroka-Beartooth Wilderness Area, and use of additional EPA approved herbicides), Alternative 2 - No Herbicide Alternative, Alternative 3 - No Action, no change from current management decisions (1987 Custer Noxious Weeds EIS and the 1987 West Fork Rock Creek EA) which limits use of many of the available herbicides, does not authorize aerial treatment, and does not allow herbicide use within the Absaroka-Beartooth Wilderness Area.

ISSUES USED TO EVALUATE ALTERNATIVES

VEGETATION, BIOLOGICAL DIVERSITY, PRODUCTION, AND STRUCTURE

There is a concern with potential impacts on vegetation, biological diversity, production, and structure from not aggressively treating weeds through an integrated pest management strategy. More specifically they were concerned about further spread of infestations and new starts of new invasive species. They were also concerned about loss of biological diversity, productiveness of the land, and changes in functional plant groups and structure of the vegetation (i.e., native grasslands converting to knapweed).

Issue Indicators:

- Potential for spread or reduction of weeds in acres.

HERBICIDES EFFECTS ON HUMAN HEALTH

There is a concern with potential impacts on human health from the use of herbicides to control weed infestation. More specifically they were concerned about the acute and chronic toxicity, and the carcinogenicity effects of low-level exposure. Some were concerned about the amounts and combination of herbicides and the synergistic effects of herbicide combinations. Respondents also wanted to know how people who are sensitive to herbicides would be protected. Some were concerned about drift from either ground or aerial applications.

Potential effects on human health from herbicides use have been addressed and considered by the EPA (Environmental Protection Agency), as well as the Forest Service. A list of documents assessing risk to human health is contained in the Human Health section of Chapter 4.

---

[2] The DEIS mailing list was based upon responses from a March 24, 2006 notice to the mailing list for project scoping. This March mailing asked for response from those interested in staying on the project mailing list and what kind of format they wanted to receive (hard copy, compact disk, executive summary, and/or access via weblink).

Issue Indicators:

- Potential for exposure and/or doses in excess of safe reference dose.
- Potential for spray drift

HERBICIDE EFFECTS ON SOILS, WATER, AND AQUATIC RESOURCES

Respondents expressed concern about effects of herbicides used for weed control on water quality and aquatic organisms (fisheries, insects and amphibians). Some respondents expressed concern about herbicide drifting from treatment areas into riparian areas, streams, and other lands with unintended consequences. The specific concern was that aerial applied herbicides could not be effectively controlled.

Issue Indicator:

- Impacts that exceed regulatory compliance thresholds;
- Potential impact of herbicides to non-target resources.

HERBICIDE EFFECTS ON THREATENED, ENDANGERED, OR SENSITIVE SPECIES AND HABITATS

There is concern about effects of herbicides used for weed control on threatened, endangered, or sensitive species and their habitats.

Issue Indicator:

- Impacts that exceed regulatory compliance thresholds;
- Potential impact of herbicides to non-target resources.

HERBICIDE EFFECTS ON WILDLIFE

There is concern about the effects of herbicides on wildlife, and the risk of bio-accumulation of herbicides within the environment.

Issue Indicator:

- Impacts that exceed regulatory compliance thresholds;
- Potential impact of herbicides to non-target resources.

OTHER ISSUES

In addition to the key issues identified earlier other concerns were expressed and protection measures (see Appendix C) were developed that reduces their significance. These concerns analyzed in Chapter 4, include the following:

- Effects on wilderness, recommended wilderness, inventoried roadless areas, wild and scenic rivers, and research natural areas;
- Effects on recreation users;
- Effects on heritage resources; and
- Effects on Social and Economic considerations, including effects on Partnerships/Cooperators.

ISSUES AND ALTERNATIVES NOT STUDIED IN DETAIL

A few issues raised during the scoping period were not analyzed in detail because: 1) there are no direct or indirect effects from the proposed action; 2) the issue is outside of the scope of decision; or 3) past research and analysis show no significant effects for similar actions.

Several alternatives for the proposed project were considered but eliminated from detailed analysis. Reasons for their dismissal include not meeting project purposes and needs; not meeting CEQ (NEPA) guidelines of being reasonable, feasible, and viable; not differing substantially from other alternatives being analyzed in detail; being beyond the scope of the EIS; and/or not complying with current laws, regulations, policies, and Forest Plan direction.

Prohibit all activities that spread weeds. An alternative that alters or eliminates activities that provides vectors for weed infestation and spread, was identified by the public during scoping for consideration as an alternative to be analyzed in the EIS. The intent of the alternative is to address and take action on human activities that promote the spread of weeds, specifically, close roads, modify authorized livestock grazing permits, and alter or eliminate existing timber, mining and recreational OHV activities. These human uses and activities are authorized through previous decisions made in the Record of Decision for the Custer National Forest Plan, which incorporates requirements of several public land laws and regulations authorizing multiple uses on National Forest Systems lands. Taking action on activities, authorized under existing public laws, regulations, permits, and the Custer Forest Plan, which may contribute to the spread of weeds, is beyond the scope of this EIS and will not be considered further.

Prevention measures that minimize establishment and spread of noxious weeds are already a part of Forest Service policy and recent decisions, and therefore will not be repeated in this analysis. The CNF fully utilizes prevention, education, and non-chemical activities to combat weeds on the forest. Herbicide, mechanical, and biological methods as addressed in this analysis would be used in conjunction with these other activities where necessary or appropriate.

No Weed Treatment. An alternative that discontinues the current weed management program was considered but eliminated from detailed analysis because it does not meet any of the project purposes, does not comply with the Forest Service's Integrated Pest Management program, is inconsistent with Forest Service policy that noxious weeds and their adverse effects be managed on National Forests, and violates federal and state laws and executive orders. It also would be irresponsible of the Forest Service to ignore weeds on the Custer National Forest when their presence may impact weed control on adjacent private and public lands.

Use Herbicide Only After Other Treatment Methods Failed. Other alternatives also eliminated from detailed analysis included mechanical, vegetative, biological, and combinations of treatments followed by herbicides application if these treatments are unsuccessful. This alternative was eliminated because there is concern that if the non-herbicidal treatments fails and some time passes before this failure is determined, the subsequent weed infestation may have expanded substantially beyond the original acreage, thus further impacting forest resources. The need for increased follow-up herbicide treatments would then have greater potential impacts than the original action. Such an occurrence would not be consistent with meeting project purposes and needs.

ALTERNATIVES CONSIDERED IN DETAIL

FEATURES COMMON TO ALL ALTERNATIVES

Best Management Practices (BMPs) for weed prevention and weed management would be included and followed (see Appendix D).

Establishing native species would be the long-term goal. Re-vegetation would only be used on those small sites most prone to erosion or in need of competing vegetation.

The Administration Travel Policy would be enforced. The policy conforms to the letter written by the Regional Forester in Appendix D of the *Off-Highway Vehicle FEIS for Montana, North Dakota, and Portions of South Dakota* (USDI BLM – USDA FS, 2001) regarding administrative off-road travel. Motorized, wheeled cross-country travel for all Northern Region employees is limited to necessary administrative and emergency business. Some examples of necessary administrative use include prescribed fire, noxious weed control, and revegetation.

Appendix E, Table E – 1 depicts weed treatment priorities to be utilized on the Custer National Forest since funding is generally not sufficient for total treatment. Priority is generally given to those new populations of aggressive invader species where long-term management can be successful. An example would be a new site consisting of five plants of salt cedar. On larger, well established infestations, such as 200 acres of leafy spurge, where long term effectiveness is questionable, containment strategies play a

much more important role. Even then control emphasis is provided along the spread vector areas such as trailheads, roadways, and parking areas.

COOPERATIVE CONTROL EFFORTS

To increase the effectiveness of all control efforts, the CNF would continue, and expand where possible, cooperative, multi-ownership weed control efforts. However, under Alternative Two, Cooperators would likely diminish or cease due to ineffectiveness of that particular IPM strategy when not applying herbicides. These efforts may include any number of the following activities:

- Share databases and information on the presence of weeds.
- Share resources such as personnel, equipment, and chemicals, as documented in any number of agreements like Challenge Cost Share Agreements, Participating Agreements, Cooperative Agreements, or Memorandums of Understanding. This would include working with counties to prioritize roads for weed treatments and developing funding agreements for weed control work along priority roads crossing CNF and county lands.
- Use input from the counties and local land owners in setting treatment priorities for any given year.
- Apply for and share grants and aid as a block of cooperators as opposed to single agencies or organizations
- Use cooperative agreements to pay for weed control work that crosses ownership boundaries.

FEATURES COMMON TO ALTERNATIVES 1 AND 2

Adaptive Management Approach

The adaptive management strategy outlined in Appendix E applies to Alternative 1- Proposed Action and Alternative 2 – No Herbicide. However, herbicide aspects of the adaptive management strategy would not be available under Alternative 2. The adaptive management approach is made up of two principle components as outlined in Appendix E.

ALTERNATIVE 1 – PROPOSED ACTION

The Custer National Forest proposes annual weed control on about 1,500 net infested acres (approximately 14,000 managed gross acres) of noxious weeds, 60 net acres tall larkspur, and 5 net acres for infrastructure maintenance (i.e., paved road shoulder maintenance). Actual treatment would provide for adaptive management practices while addressing current infestations as follows:

- About 1415 net infested acres ground herbicide application is proposed (includes 45 acres of in the AB Wilderness Area);
- About 85 net infested acres aerial treatment application is proposed. Currently, there are about 5 net acres of infestation in the Dry Creek area and about 80 net acres of infestation in the Stillwater area. These areas have potential for aerial treatment needs in the near future due to their remote and steep characteristics. These characteristics reduce the ability for effective ground treatment and have a potential to spread to about 7,300 acres of remote and inaccessible areas.
- About 155 acres biological control is proposed. Herbicide treatment will be used along the perimeter and small patches to contain the weeds. Current targeted areas include 80 Ac Stillwater, 5 Ac Dry Creek, 28 Ac Rock Cr, 20 Ac Ski Run Rd, 2 Ac Pryor Mountain (Beartooth Ranger District), 10 Acres Powder River Breaks (Ashland Ranger District), 10 Ac Long Pines (Sioux Ranger District).
- Less than 5 acres is proposed to be treated by hand-pulling (herbicides may be used to reduce plant density to low levels, then pull isolated plants);
- Less than 5 acres of cultural treatment of seeding is proposed. Herbicides or grazing may be used to reduce plant density, then plant more desirable and competing vegetation; tilling or burning will most likely apply if future populations are more sizable as to make the treatment more cost effective.
- About 60 acres of tall larkspur control of ground herbicide application is proposed.

- Less than 5 acres for infrastructure maintenance or construction. This includes periodic treatment along paved road shoulders. This will help maintain paved road investment by reducing undesirable plant growth from creating hairline cracks in and along shoulders of paved roads. Treatment would be within one foot from paved road shoulders and a minimal amount of hairline cracks in paved roads. Other examples include helibases, drainage culverts, special use permits such as telephone and electric transmission lines that may have undesirable vegetation growing in or adjacent to them. Undesirable plants may increase maintenance costs of the infrastructure, can be a safety problem, or cause injury.

Implementation would occur within a 15 year period. Not all acres would be treated every year. Acres treated will depend on available funding and on a priority rating system described in Appendix E, Table E - 1. Historical funding has allowed for treatment of between 600 and 1,200 acres annually. Most areas would need repeated treatment for 5 to 8 years to ensure effective control. Monitoring would be used to determine effectiveness and to identify areas that would need to be re-treatment or if treatment areas could be reduced based on effectiveness of previous treatments.

Appendix A has a current list of 53 invasive and poisonous plants that occur on the Custer Forest or occur nearby. Under Alternatives 1 and 2 the list will be updated as new plants are recognized as a threat to the ecosystem or agricultural economics. Alternative 3 is limited to the plants listed in the 1987 Custer Forest Noxious Weeds Control EIS, and the 1987 West Fork Rock Creek EA.

Under the proposed action alternative new weed infestations could be treated provided that the steps identified in the Adaptive Management section (Appendix E) are followed. They include criteria to help determine the appropriate treatment for new weed sites. All infestations will use the priority decision process outlined in the Appendix E, Table E – 1 to determine the type of treatment on each weed infestation. If the weeds are in the AB Wilderness, then Wilderness Minimum Tool Guidelines found in Appendix E, Table E - 3 will be used.

One feature of the proposed action Alternative 1 is the flexibility to use updated agents as they are registered and approved by the EPA (see Appendix E). All herbicides will be applied according to label specification; or when additional protection measures are required by Forest Service policy as described in this chapter and Appendix C. Impacts on soil and water will be mitigated to meet public land water laws, state pesticide application requirements, Northern Region Soil and Water Standards, and Custer Forest Plan Standards. Appendix G lists the herbicides addressed in this analysis. Appendix E outlines adaptive management that would be used to address use of herbicides or biological agents not analyzed in this analysis. The herbicide section in chapter 3 displays herbicide properties regarding the physiological or biochemical activity and behavior in or on soils.

Herbicide selection would be based on environmental conditions (such as groundwater vulnerability, proximity to water, and non-target vegetation) to meet management objectives. Appendix F displays herbicide effectiveness by species. Appendix I display examples of herbicides proposed for use and a range of application rates. Appendix I also displays other treatments and their effectiveness by species. Herbicide selection considers the following criteria:

- Herbicide label considerations;
- Herbicide effectiveness on target weed species;
- Proximity to water or other sensitive resources;
- Soil characteristics;
- Potential unintended impacts to non-target species such as conifers or shrubs;
- Application method (i.e., aerial, ground, or wick applicator);
- Other weed species present at the site, and effectiveness of herbicides on those species (for example spotted knapweed infestations with inclusions of toadflax);
- Adjacent treatments (private land);
- Timing of treatments (spring/fall) for effectiveness; and
- Priority weed – new invaders vs. existing.

ALTERNATIVE 2 – NO HERBICIDE

This alternative describes a weed control program as outlined in Alternative 1, but that does not use herbicides. The adaptive management strategy applies to this Alternative as do priority criteria (see Appendix E). However, herbicide aspects of the adaptive management strategy would not be available under Alternative 2.

Under Alternative 2 the following activities would occur: less than five net acres of hand pulling or other mechanical or cultural treatments, and 155 net infested acres with biological control agents (primarily knapweeds and leafy spurge).

Approximately 60 acres tall larkspur could be treated with sheep. Sheep are more resistant to larkspur poisoning than cattle. Grazing larkspur with sheep before cattle turn-in may reduce the threat of cattle poisoning. Sheep, however, are not necessarily consistent in grazing various species of larkspur, but they could be compelled to increase consumption by trailing or bedding in larkspur patches (Michael H. Ralphs and John D. Olsen, 1992). This treatment of larkspur would largely be dependent upon the permittees' commitment to the treatment and is currently unlikely to be a preferred option for permittee commitment.

This alternative would also result in 1,345 net infested acres not being treated for the following reasons: (1) there is not an approved biological control agent or very limited effectiveness; (2) the weed patch is too large and can not be hand pulled because of lack of resources; and/or (3) the plant spreads via roots and extensive soil disturbance is not acceptable.

The effectiveness of these treatments is diminished because weed density will not be controlled with herbicides. Mechanical treatments will only occur in areas with low weed density (a few weeds per acre) for maximum cost effectiveness. Cultural treatments, such as seeding native plants without removing the weeds will cause a decrease in seedling survival due to plant competition. Biological control agents that are currently available will only reduce the plant density of a few weed species (most agents have not been effective as of yet) and will not prevent the weeds from spreading into new areas.

ALTERNATIVE 3 – NO ACTION, NO CHANGE FROM CURRENT WEED TREATMENT

This alternative is the same as current management practices covered by previous NEPA decisions. No additional herbicide treatment would occur outside of those areas identified in the 1987 Custer National Forest Noxious Weeds Control EIS and the 1987 West Fork Rock Creek EA. Alternative 3 would allow for treatment of listed noxious weed species with only four herbicides (2, 4-D, picloram, dicamba, and glyphosate), and allows for manual, cultural, and biocontrol treatments (the 1987 Noxious Weeds EIS combined these activities). This Alternative would not treat about 45 acres inside the AB Wilderness Area with herbicides because it was not analyzed in the previous environmental analysis. No larkspur or infrastructure herbicide treatments would occur under this alternative. No aerial treatment would be done under this alternative. There would be no allowances for adaptive management strategies to be employed for new species, infestations, or herbicides.

A summary of the different treatment types for each alternative is provided in Table 2 - 1. Maps of treatment areas by Alternatives by Ranger District are displayed in Map Section, at the end of this document. More detailed and larger scaled maps are available in the project file.

TABLE 2 - 1. TREATMENT ACRES (NET AREA) BY ALTERNATIVE[3]

Alt.[4]	Biological Control	Cultural/ Mechanical*	Aerial Herbicide	Ground Herbicide	Ground Herbicide inside Wilderness	Tall Larkspur Herbicide	Infra-structure Herbicide	Weed Acres Not Treated by Herbicide
1	155	5	85[5]	1415	45	60	5	0
2	155	5	0	0	0	0	0	1340
3	155	5	0	1415	0	0	0	45

CHOOSING TREATMENT METHODS

Selection of weed management tools is not a choice of one tool over another, but rather selection of a combination of tools that would be most effective on the target species for a particular location. Reliance on one method or restricting the use of one or more weed management tools may prove less effective. Effectiveness and applicability of each tool varies and depends on weed biology and ecology, location and size of the infestation, environmental factors, management objectives, and management costs. Methods include mechanical, cultural, biological, and chemical.

See Chapter 3 for use of these treatments and Appendices F and J for technique effectiveness for individual weed species. Table 2 - 2 displays a comparison of Treatment Methods by Alternative.

TABLE 2 - 2. COMPARISON OF TREATMENT METHODS BY ALTERNATIVE

Treatment Type	Alternative 1 Proposed Action	Alternative 2 No Herbicide	Alternative 3 Current Direction
Manual	All manual techniques known to be useful for treating invasive plants	Same as Proposed Action.	Hand pulling and use of hand tools.
Mechanical	Same as Current Direction	Same as Proposed Action.	Any mechanical tool that is known to be useful for treating invasive plants.
Biological	Agents used would be APHIS and State-approved. Agents demonstrated to negatively impact non-target organisms would not be used.	Same as Proposed Action	Agents used would be APHIS and State approved
Cultural	Same as Current Direction, plus mulching with a variety of materials, and other local remedies that may be determined to be effective.	Same as Proposed Action.	Grazing animals, addition of fertilizer/soil amendments, competitive planting or any other cultural practice known to be useful for treating undesirable plants.
Herbicides	Herbicide formulations and mixtures containing one or more of the following active ingredients: 2, 4-D, aminopyralid, chlorsulfuron, clopyralid, dicamba, diuron, glyphosate, hexazinone, imazapic, imazapyr, metsulfuron methyl, picloram, sulfometuron methyl, and triclopyr, and associated adjuvants. Ammonium sulfate, an adjuvant, can also be used as an herbicide for use of larkspur control. All of herbicide application methods are allowed including wicking, wiping, injection, spot, ground level broadcast and aerial, as permitted by product label.	No herbicides would be used.	Herbicide formulations containing only the following active active ingredients are permitted glyphosate, picloram, dicamba, and 2, 4-D and associated adjuvants. All application methods consistent with label requirements are permitted. Only ground applications outside of the AB Wilderness are permitted. No aerial applications are permitted.

[3] Some acres are counted more than once because more than one species is present on the same site and each species may have unique treatment strategy.
[4] For all alternatives except Alternative 2, herbicides will be used in conjunction with biological, cultural, and mechanical control methods.
[5] Aerial estimated acreage are mapped where infestations are currently spotty, but are anticipated to grow rapidly due to the difficulty in treating weeds in rough and inaccessible terrain.

Treatment Type	Alternative 1 Proposed Action	Alternative 2 No Herbicide	Alternative 3 Current Direction
	Ground applications permitted in entire project area, including the AB Wilderness Area. Aerial applications are not permitted in the AB Wilderness.		

MONITORING

A monitoring program would be incorporated as part of each alternative. Monitoring is the collection of information to determine effectiveness of management actions in meeting prescribed objectives. Monitoring would focus on the: 1) density and rate of spread, and the effect these aggressive plants have on natural resources; 2) effects of herbicides on noxious weeds; 3) establishment and effectiveness of biological control agents; and 4) presence of herbicide in surface or ground water in high risk areas (i.e. accidental spills, aerial application), and 5) implementation of protection measures.

The weed monitoring program includes annual survey and mapping of weed populations and treatment areas. In addition, long term herbicide test plots and long term biological control plots may be established for the purpose of tracking the effectiveness of control.

Monitoring of herbicide use will be completed annually and on a daily basis during periods of herbicide application. Per state requirements, daily herbicide application logs will be kept and will include information on the type of herbicide, total amount of the herbicide used, method of application, and location of treatment. This information will be consolidated in the annual Forest Service Pesticide Use Report.

For aerial herbicide application, adjacent sensitive resources (streams, lakes, wetlands, and sensitive plants) would be monitored to determine the amount and distribution of spray drift. Spray detection cards would be placed along the perimeter of the treatment area and inside the buffer around sensitive areas. The cards would be visually examined immediately after spraying and photographed. A written summary of the drift pattern as interpreted from the detection cards and the photos would be used to document the result. If necessary, aerial application methodology will be modified (change buffer size, change droplet size, and use different weather parameters) to reduce the amount of drift.

A Custer NF noxious/invasive plant inventory and database using national protocols will be maintained (TERRA and FACTS). Districts should annually monitor treated infestations to determine expansion and/or reduction of infestations over time.

Until the City of Red Lodge started using a well for their water source, the West Fork of Rock Creek historically served as the main water source for the city of Red Lodge. This area also received annual picloram treatments on weeds (mostly spot treatments with minor amounts of broadcast treatment). Because of this association with domestic use of the West Fork of Rock Creek water, the Beartooth Ranger District annually conducted water quality sampling and monitoring for picloram between 1990 and 2004. This area is also considered to be at high risk to groundwater contamination according to Chapter 4, Table 4 – 10 and the Ground Water Vulnerability map outlined in the Map section of the EIS. The design criteria and protocols used when treating weeds during this time period were similar to and somewhat less stringent than what is being proposed under the proposed action, Alternative 1. Test results have never shown any levels of picloram.

The following are situations of higher risk where an interdisciplinary team should evaluate whether or not water quality monitoring (surface or groundwater) is recommended for line officer support and approval. A high commitment to water quality monitoring in these high risk situations is strongly encouraged.

- Whenever there is reason to suspect that herbicides may have entered water during a spraying operation (such as herbicides detected on drift cards, or if a spill[6] occurred),

[6] Chapter 5 contains a web link to a bioassay technique using aquatic species sensitive to herbicides (including brook and rainbow trout). This technique is outlined in EPA toxicity testing manual entitled: *"Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms", EPA/600/4-90/027, September 1991.*

- In situations of large-scale broadcast treatment using persistent herbicides (i.e. picloram), especially within highly leachable soils and proximity of depth to ground water (see Chapter 4, Table 4 – 10), or in close proximity to surface waters
- When picloram levels approach the maximum allowable annual treatment acreage by watershed (sixth code level hydrologic unit – see Chapter 4, Table 4 – 14).

The associated water quality monitoring should display sampling locations relative to the area of herbicide treatment, parameters to be monitored, methodologies to be used, frequency, pattern and number of samples to be collected. Typically, samples should be collected immediately after spraying. Water samples could also be collected after the first substantial rain to detect herbicides that could possibly enter surface water through leaching or runoff. Laboratory analysis, by an independent lab, should test the water samples for herbicides. The design of the monitoring should:

- Ensure State water quality objectives and standards are met
- Provide a mechanism to initiate additional measures if needed to meet State water quality standards and goals
- Evaluate the effectiveness of the Best Management Practices utilized in a project
- Evaluate the accuracy of estimates made in the analysis, and
- Provide a feedback mechanism for future projects.

PROTECTION MEASURES

Appendix C outlines the environmental protection measures that would be implemented for each alternative. These are management requirements and constraints that apply to various aspects of weed treatments.

ENVIRONMENTALLY PREFERRED AND AGENCY PREFERRED ALTERNATIVE

Alternative 1 is both the environmentally and agency preferred alternative because it best meets public land laws and protects native species and habitat diversity with protection measures adequate to protect other resource values.

SUMMARY COMPARISON OF ALTERNATIVES

With each alternative, there is a trade-off between beneficial and adverse impacts. This section focuses on issues described earlier in this Chapter. Key components of these issues are impacts to human health, non-target plants, animals, fish, soils, and water. These tradeoffs are analyzed in Chapter 4 and summarized in the Table 2 - 3. Impacts are based upon the application of appropriate protection measures discussed in this chapter.

TABLE 2 - 3. SUMMARY OF POTENTIAL IMPACTS BETWEEN ALTERNATIVES

Issue or Concern	Potential Impacts		
	Alt. 1- Proposed Action	Alt. 2 – No Herbicides	Alt. 3- No Action; Current Management
Impacts of weed spread:			
• **Loss of native plant community; wildlife and fisheries habitats**	- Maximizes native species emphasis	- High loss of natives from weeds	- Moderate loss of natives from weeds
• Loss of sensitive plant populations;	-Low risk, effective protection measures	-High risk (weeds out compete rare plants)	-High risk (weeds out compete rare plants)
• **Human Health (e.g. allergies, asthma)**	- Decrease weed impact	- Increased allergies	- Decrease weed impact
• **Social/Economics**	-Moderate economic improvement; containment and control of weed infestations	-Spread of weeds would continue and impact wildlife and aquatic habitats, biological integrity, forage bases; fire regimes, partnership and cooperator relationships, and continued animal death from poisonous weeds. Social lifestyles associated with Wilderness experience will be diminished.	-Moderate economic improvement; containment and control of weed infestations. Continued animal death from poisonous weeds. Social lifestyles associated with Wilderness experience will be diminished.
Impacts of using herbicides:			
• **Human health;**	-Low risk of worker exposure to herbicides due to area treated and IPM methods, effective protection measures;	- No potential for worker exposure to herbicides; some risk involved with mechanical methods such as tilling.	-Low risk, effective protection measures
• **Fish and animals;**	-Low risk, effective protection measures; short-term habitat impact; insignificant Forestwide.	- No risk	-Low risk, effective protection measures; short-term habitat impact; insignificant Forestwide.
• **Non-target plants;**	-Low risk, effective protection measures; short-term habitat impact; insignificant Forestwide.	- No risk	-Low risk, effective protection measures; short-term habitat impact; insignificant Forestwide.
• **Water quality**	-Low risk, effective protection measures.	- No risk	-Low risk, effective protection measures
• **Heritage Resources**	-Low risk, effective protection measures.	- No risk	–Low risk, effective protection measures.
Additional risks of aerial spraying:			
• **Human health;**	-Low risk, effective protection measures	N/A –no aerial herbicide application	N/A – no aerial herbicide application
• **Fish and animals;**	-Low risk, effective protection measures		
• **Non-target plants.**	-Low risk, effective protection measures.		
Impacts of Non-herbicide treatments (Mechanical and Cultural)			
• **Air Quality**	-Moderate short-term emissions; air quality standards will not be exceeded.	-Moderate short-term emissions; air quality standards will not be exceeded	-Moderate short-term emissions; air quality standards will not be exceeded.
• **Water Quality / Fisheries**	-Insignificant effects to water quality; effective protection measures.	-Insignificant effects to water quality.	-Insignificant effects to water quality; effective protection measures.
• **Soils**	-Low potential for short-term insignificant soil	-Moderate to low potential for short-term insignificant soil	-Low potential for short-term insignificant soil impacts or

Issue or Concern	Potential Impacts		
	Alt. 1- Proposed Action	Alt. 2 – No Herbicides	Alt. 3- No Action; Current Management
	impacts or surface erosion from mechanical treatment methods.	impacts or surface erosion from mechanical treatment methods.	surface erosion from mechanical treatment methods.
• Vegetation	-Best weed control; minimum impact to non-target vegetation from biological treatment.	-Poor weed control by mechanical methods with minimum impact to non-target vegetation from biological treatment.	-Good weed control with minimum impact to non-target vegetation from biological treatment.
• Heritage Resources	-Some to low probability of site damage from mechanical methods.	-Some probability of site damage from mechanical methods.	-Some to low probability of site damage from mechanical methods.
Wilderness Character • Natural Integrity	-Maximizes natural integrity	-Natural integrity erodes the most with increasing weed infestations. Higher probability for recreation setting to be disturbed by stickers and weed latex.	- Natural integrity erodes some with increasing weed infestations.
• Solitude and Remoteness	-Minor short-term effects when recreational users encounter weed control crews.	-Short-term effects, crews spend more time treating weeds, chance for encounters increase.	-Minor short-term effects when recreational users encounter weed crews.
• Regional Forester Authority	Pesticide Use Proposal needs approval from Regional Forester	N/A	Pesticide Use Proposal needs approval from Regional Forester (FSM 2150)
Visual / Recreation Setting / Wild and Scenic Rivers	Little to no visual disturbance from biological methods; some short/long-term reoccurring visual disturbance from tilling/burning; little effect on recreation setting. Good improvement at recreation sites with treated infestations. Temporary closure during treatment.	Little to no visual disturbance from biological methods; some short/long-term reoccurring visual disturbance from tilling/burning; little effect on recreation setting. More likely to encounter plant annoyances such as stickers, burs, and weed latex. No additional constraints required.	Little to no visual disturbance from biological methods; some short/long-term reoccurring visual disturbance from tilling/burning; little effect on recreation setting. Good improvement at recreation sites with treated infestations. Temporary closure during treatment
Social and Economic Considerations	Some loss of forage and habitat for livestock and wildlife. The impact of weed infestations spreading on the private land and being an additional hardship is less likely. Partnerships continue.	Higher loss of forage and habitat for livestock and wildlife. The impact of weed infestations spreading on the private land and being an additional hardship is much more likely. Partnerships are not likely.	Some loss of forage and habitat for livestock and wildlife. The impact of weed infestations spreading on the private land and being an additional hardship is less likely Partnerships continue.
Effectiveness of control actions • Limit spread, or eliminate existing infestations	Very Effective	Not Very Effective	Effective on limited area; no herbicide use in AB Wilderness; no adaptive management and fewer protection measures than Alternative 1.
• Percent area treated based on current budget.	80-95 % plus adaptive management options for new infestations.	10 %	70-80 %

CHAPTER 3

AFFECTED ENVIRONMENT

INTRODUCTION

This chapter describes existing conditions for resource areas within the National Forest that may be affected by the alternatives. The resource summaries focus on those aspects of the physical, biological, and human environment most likely to be affected by the alternatives. More detailed information on each resource can be found in the resource specialist's reports in the project file.

REGULATORY FRAMEWORK

FOREST PLAN MANAGEMENT DIRECTION

Management direction for weed control on the CNF is set at the national and forest levels. As described in Chapter 1, federal laws guide implementation of noxious weed control actions. Forest Service policies developed in response to these laws are set forth in Forest Service Manual 2080, Noxious Weed Management. These policies are incorporated into the 1987 Custer National Forest Land and Resource Management Plan (Forest Plan) and the proposed action (Alternative 1).

Management direction of the CNF is found in the Forest Plan which provides Forest-wide goals and objectives for managing diverse resources (Forest Plan, II-3 and II-24). A general management goal of the CNF is to implement an integrated pest management program, as described in the Forest Plan on page II-3. Relevant area-wide management goals found in the Forest Plan (p. II-24) include:

- An integrated pest management approach to noxious weed treatment will be used with control emphasized on new starts, priority areas, and areas of minor infestations. Holding actions will be implemented on areas of existing large infestations. Noxious weed infestations will be inventoried periodically to monitor existing and new infestations. This effort will include cooperation with livestock producers, grazing associations, county weed boards, state agriculture departments, other Federal agencies, state and Federal research organizations, and adjacent landowners.
- The priorities of control efforts will be: a) on areas where small infestations, including new starts, can be eliminated, contained, or reduced in size, b) containment of large infestations, and c) control of the entire infestation. Emphasis will be given to treatment on a drainage basis in cooperation with all landowners.
- Only those chemicals which are labeled under State and Federal laws for target species, and which experience and research have proven effective for weed control, will be used. Chemical treatment will be avoided in areas where such treatment will have a significant impact on water resources, key wildlife habitat or unique vegetation. Isolated new noxious weed starts will be controlled to prevent further expansion into these habitats. Where chemicals are used, techniques will be utilized to reduce the amount applied per acre. All pesticide applicators on National Forest System lands will be certified under the applicable Federal of state law. The use of chemicals will be in agreement with NEPA requirements.
- Biological control techniques which become available and are proven safe and effective will be favored over chemical methods. Research efforts by universities and research stations will be encouraged and new feasible technology resulting from this research will be applied.
- Pre- and post-evaluations of effectiveness will be completed on all weed control projects.

Management area descriptions are found in Chapter III of the Custer Forest Plan. These descriptions provide specific goals and management direction to achieve the Forest-wide goals and standards of the Forest Plan. Proposed actions could occur on all management area allocations identified in the Forest Plan. None of the management areas restrict the control of noxious weeds. Some management areas, however, restrict motorized access. The Forest Service may use motorized vehicles to apply weed control

in closed areas, when necessary, by obtaining a variance to the closure order. Steps will be taken to minimize tracks, by staying on established tracks. Weed control methods will comply with motorized restrictions in Wilderness Areas and Research Natural Areas.

Among the resource goals listed in chapter II of the Forest Plan, the proposed activities directly or indirectly address the following goals (paraphrased and emphasis added):

- *Threatened and Endangered Species:* Conserve listed endangered and threatened species and their habitats. This includes conservation of listed sensitive species and their habitats (Forest Plan, page II-17).
- *Watershed Quality and Fisheries:* Maintain or improve quality of watersheds, including water quality and soil productivity. Maintain water quality and quantity in order to maintain fish habitat (Forest Plan, page II-19).
- *Key Indicator / Wildlife Species and Habitat:* Maintain and improve habitats for these species (Forest Plan, page II-16-19).
- *Research Natural Areas:* Provide natural occurring ecological processes within Research Natural Areas (Forest Plan, page III-78).
- *Wilderness Values:* Maintain Wilderness values through use of weed seed free forage use and noxious weed control. (Forest Plan, Appendix II, pages 155-156)

AGENCY POLICY AND DIRECTION

Important policy and direction relevant to weed control is given in the Chief's Natural Resource Agenda (1998), the Northern Region Overview, and the Forest Service Manual. It is also emphasized as one of the four threats to National Forest System lands as outlined by the current Chief of the Forest Service.

1988 Natural Resource Agenda. In March of 1998, Forest Service Chief Mike Dombeck presented the Agency's emphasis in management direction for the 21st century. In this Agenda was a strong emphasis on conserving and restoring degraded ecosystems, including actions to "attain desirable plant communities", and "prevent exotic organisms from entering or spreading in the United States."

Forest Service Manual 2259.03. "Forest office shall cooperate fully with State, County and Federal officials in implementing 36 CFR 222.8 and sections 1 and 2 of PL 90-583 (see below). Within budgetary constraints, the Forest Service shall control to the extent practical, noxious farm weeds on all National Forest System lands."

Forest Service Chief's Four Threats: Forest Service Chief, Dale Bosworth, describes that in the 21st century, the nation's forests and grasslands face four threats. Invasive species is a listed threat, along with fire and fuels, loss of open space, and unmanaged recreation. Management emphasis is being placed on these four threats. Of 2,000 nonnative plants found in the United States, 400 are invasive species. The U.S. spends $13 billion per year to prevent and contain the spread of invasives. For all invasives combined, the price tag is $138 billion per year in total economic damages and associated control costs (http://www.fs.fed.us/projects/four-threats/index.shtml).

LAWS AND REGULATIONS

Laws and regulations give both broad and specific authority and direction for control of noxious weeds on National Forest system lands. These laws and regulations are found in Chapter I.

ENVIRONMENTAL JUSTICE

Executive Order 12898, "General Actions to Address Environmental Justice in Minority Populations and Low Income Populations, requires all Federal agencies to incorporate environmental justice into their mission. The well-being and the health of minorities and low income groups were not identified as an issue during scoping. American Indian Tribes are located within the region. However, issues of disproportionate distribution of project impacts have not been identified regarding any racial minorities or impoverished populations within the project area that might be affected by implementation of this project. The proposed action would not disproportionately affect minority or low-income populations.

NATIVE AMERICAN TREATY RIGHTS

Many tribes use areas within the Custer National Forest. The Crow, Northern Cheyenne, Assiniboine, Shoshone, Arapahoe, Shoshone-Bannock, Three Affiliated, and the Great Sioux Nation, have treaty rights under the 1851 Fort Laramie Treaty to use the National Forests for hunting and gathering.

AFFECTED ENVIRONMENT

VEGETATION

Vegetation - Regulatory Framework

Chapter 1 and the previous section (Agency Policy and Direction; and Law and Regulations) discussed the regulations that pertain to weeds.

Vegetation - Affected Area

The analysis area for vegetation includes all vegetation communities in proximity to proposed treatment areas or those habitats where weeds have potential to invade. These plant communities have the potential to be directly or indirectly impacted by weeds and proposed treatment methods.

Vegetation - Analysis Method

Information used came from data on file at the Custer National Forest, literature review, and personal communications with resource specialists with knowledge of vegetation, weed control, and herbicide effects. Acreage values were derived utilizing GIS.

Vegetation - Affected Environment

Components of the affected vegetation are the weed species themselves, and the native plants communities. The vegetation information is presented in three sub-sections: Weed Species; Native Plant Communities; and Rare Native Plant Species.

WEED SPECIES

Of the 2000 plus vascular plant species that have been documented on the CNF, 16 that occur on the CNF are considered weeds. However, an additional 37 species are listed as occurring adjacent to the CNF for a total of 53 species of concern (see Appendix A). Most of these species only grow in highly disturbed areas where there has been severe disturbance to the ground (such as parking lots, gravel pits, or horse corrals). Many of these weeds are unable to compete with native vegetation and are benign in their effects to the natural environment.

The Custer National Forest could experience a massive invasion of spotted knapweed, leafy spurge, houndstongue, Canada thistle, sulfur cinquefoil, Dalmatian toadflax, and/or yellow toadflax in the very near future, especially in light of some of the large scale wildfires that have occurred and will likely continue to occur.

Some weed species, however, are extremely hardy, competitive, and have the ability to displace native plant species and permanently alter the structure, composition and function of native plant communities. These species are considered very invasive and are typically listed as noxious by States. Many plant species have been identified as an undesirable weed on the CNF (see Appendices A and B). For purposes of this analysis, a weed is defined as any plant that interferes with management objectives for a given area of land (or body of water) at a given point in time. Throughout this document references to weeds include noxious, exotic, invasive, other undesirable species, and poisonous plant species.

There are around 275 invasive plant species in or adjacent to the Custer National Forest (Appendix B). Of these, a weed species concern list of 53 species (Appendix A) has been formulated based on species occurring on noxious weed lists by state and county, on invasive lists from adjacent lands (Greater Yellowstone), and undesirable poisonous species.

Of the 53 concern species listed in the area (Appendix A), 16 have been located and mapped on the Forest. Tables 3 – 1 through 3 -6 displays the acreage for each of these weed species. Canada thistle, spotted knapweed, houndstongue, and leafy spurge are the predominant noxious weed species, comprising 96 percent or 1,400 net acres of the Custer National Forest inventory of 1,458 net acres. The remaining weed species, of varying densities, grow on the remaining four percent or 58 mapped net acres. The acres identified are by species and not by overall infestation area. Due to some sites having multiple weed species the actual infested acreage may be slightly overestimated.

The 53 species of concern for the Custer National Forest include:

- 28 weed species listed as State noxious weeds in Montana and South Dakota found within the counties associated with the Custer National Forest.
- Nine additional weed species listed by counties as being noxious.
- 12 additional weed species listed by the Greater Yellowstone Coordinating Committee and the State of Wyoming (in consideration of their proximity to the Custer National Forest).
- One additional species (tall larkspur) listed by the Custer National Forest as an undesirable poisonous plant to livestock.

Although species have been identified as invasive as of the time of this analysis, it is important to convey the dynamic nature of this list. Every year, counties reassess their noxious weed lists to determine if additions or deletions are needed. The changing nature of the lists is caused by the rapid influx of exotic species into this area in recent years. Although particular species will be highlighted and discussed in this document, it is important to understand that the general discussion regarding invader species applies to any species currently identified as invasive.

In order to better describe the current threat, distribution, and level of concern for invaders, the weed categories as defined by Montana's County Noxious Weed Control Act have been adopted for this analysis. This strategy categorizes weeds by their invasive status. Every weed is categorized in one of three categories, described below. The Tables 3 – 1 through 3 - 6 display the invader species by category, along with known presence on ranger districts.

Category 1 species (wide-spread) are the most difficult to assess because they are so widely distributed. There are good indications based on field observations and documented sightings that species in this category exist in much of their potential habitat in the CNF. This is not to say that there is no room for expansion. On the contrary, many sites currently house small infestations that could grow significantly.

The alpine/subalpine settings (including those settings in the Absaroka-Beartooth Wilderness Area) are noted as the exceptions to this assumption for Category 1 invaders, because many potential sites in these areas are not currently infested nor do they have environmental conditions conducive to weed establishment.

Category 2 species (new invaders) are expected to be very limited in their distribution in or near the project area. Less than an acre of Salt Cedar on the Ashland Ranger District and about 3 acres of common tansy on the Beartooth Ranger District have been recorded.

Category 3 species (potential invaders) are expected to be very limited in their distribution in or near the project area. A trace amount of common crupina has been recorded on the Sioux Ranger District.

The following tables display Custer National Forest's Category 1, 2, and 3 Weed Acreage by Ranger District. Due to some sites having multiple weed species the actual infested acreage may be slightly overestimated.

TABLE 3 – 1. BEARTOOTH RANGER DISTRICT NOXIOUS WEEDS[1]

Acreage Summary by Ownership Within NFS Boundary[2]

Common Name	Category[3]	USFS Gross[4]	USFS Infested[5]	Private Gross	Private Infested	Total Gross	Total Infested
Leafy Spurge	1	29.5	13.9	5.1	4.2	34.6	18.1
Spotted Knapweed	1	2145.9	127.8	12.8	9.5	2158.7	137.3
Canada Thistle	1	2448.0	142.9	1.0	0.3	2449.0	142.2
Russian Knapweed	1						
Field Bindweed	1	7.4	0.8			7.4	0.8
Houndstongue	1	851.8	57.8	0.9	0.7	852.7	58.5
Dalmatian Toadflax	1	55.4	5.1	3.0	3.0	58.4	8.1
Yellow Toadflax	1	7.1	3.9			7.1	3.9
Oxeye Daisy	1	29.2	3.8			29.2	3.8
Sulfur Cinquefoil	1	201.4	8.5	12.6	9.4	214.0	17.9
Salt Cedar	2						
Meadow Hawkweed	2	0.1	0.1			0.1	0.1
Common Tansy	2	3.3	3.3			3.3	3.3
Common Crupina	3						
Common Mullein	Roadside Weed	Trace					
Musk Thistle	Roadside Weed	Trace					
Perennial Sow Thistle	Roadside Weed						
Total		**5779**	**367**	**35**	**27**	**5814**	**394**

TABLE 3 – 2. BEARTOOTH RANGER DISTRICT NOXIOUS WEEDS

Acreage Summary by County (USFS managed lands only)[6]

Common Name	Category	Carbon Gross	Carbon Infested	Stillwater Gross	Stillwater Infested	Sweet Grass Gross	Sweet Grass Infested
Leafy Spurge	1	17.0	7.7	17.6	10.3		
Spotted Knapweed	1	1463.1	84.7	638.8	48.6	56.7	0.5
Canada Thistle	1	1329.7	52.4	936.9	82.7	182.4	7.1
Russian Knapweed	1						
Field Bindweed	1	7.3	0.7	0.1	0.1		
Houndstongue	1	456.9	12.6	339.1	45.5	56.7	0.5
Dalmatian Toadflax	1	56.4	7.9	2.0	0.2		
Yellow Toadflax	1	3.0	0.5	4.0	3.3		
Oxeye Daisy	1	25.2	0.8	4.0	3.1		
Sulfur Cinquefoil	1	150.3	7.9	63.7	3.7		
Salt Cedar	2						
Meadow Hawkweed	2	0.1	0.1				
Common Tansy	2	0.1	0.1	3.2	3.2		
Common Crupina	3						
Common Mullein	Roadside Weed						
Musk Thistle	Roadside Weed						
Perennial Sow Thistle	Roadside Weed						
Total		**3509**	**175**	**2009**	**211**	**296**	**8**

[1] As Of 6-15-2004
[2] Acreage falls within Beartooth Weed Management Area.
[3] Category 1, Wide Spread, Category 2, Rapid Spreading, Category 3, New Invader
[4] Gross acreage is a mapped unit around infestations and does not necessarily represent actual infested acres.
[5] Infested acreage is the estimated infested portions of an overall gross mapping unit and more closely represents areas receiving actual treatment.
[6] No infested areas known to occur in Park County at this time

TABLE 3 – 3. SIOUX RANGER DISTRICT NOXIOUS WEEDS[7]

Acreage Summary by Ownership Within NFS Boundary

Common Name	Category[8]	USFS Gross	USFS Infested	Private Gross	Private Infested	State Gross	State Infested	Total Gross	Total Infested
Leafy Spurge	1	62.0	23.8	1.0	0.2	1.9	0.2	64.8	24.1
Spotted Knapweed	1	18.8	13.6					18.8	13.6
Canada Thistle	1	1151.3	748.6	0.4	0.4	7.9	5.4	1159.6	754.3
Russian Knapweed	1			0.1	0.1			0.1	0.1
Field Bindweed	1								
Houndstongue	1	97.2	23.7	0.1	0.1	1.0	0.2	98.3	24.0
Dalmatian Toadflax	1								
Yellow Toadflax	1								
Oxeye Daisy	1								
Sulfur Cinquefoil	1								
Salt Cedar	2								
Common Tansy	2								
Common Crupina	3								
Common Mullein	Roadside Weed	12.6	9.2					12.6	9.1
Musk Thistle	Roadside Weed	4.1	4.0					4.1	4.0
Perennial Sow Thistle	Roadside Weed	3.1	3.0					3.1	3.0
Other	Roadside Weed	9.6	5.1	3.0	1.1	1.0	0.8	13.6	7.0
Total		**1359**	**831**	**5**	**2**	**12**	**7**	**1375**	**840**

TABLE 3 – 4. SIOUX RANGER DISTRICT NOXIOUS WEEDS

Acreage Summary by County (USFS ownership only)

Common Name	Category	MT-Carter Gross	MT- Carter Infested	SD-Harding Gross	SD-Harding Infested
Leafy Spurge	1	58.9	22.3	3.0	1.5
Spotted Knapweed	1	18.8	13.6		
Canada Thistle	1	1142.1	746.6	9.3	2.0
Russian Knapweed	1				
Field Bindweed	1				
Houndstongue	1	97.2	23.7		
Dalmatian Toadflax	1				
Yellow Toadflax	1				
Oxeye Daisy	1				
Sulfur Cinquefoil	1				
Salt Cedar	2				
Common Tansy	2				
Common Crupina	3				
Common Mullein	Roadside Weed	12.6	9.2		
Musk Thistle	Roadside Weed	4.1	4.0		
Perennial Sow Thistle	Roadside Weed	3.1	3.0		
Other		9.6	5.1		
Total		**1346**	**827**	**12**	**3**

[7] As Of 6-15-2004

[8] Category 1, Wide Spread, Category 2, Rapid Spreading, Category 3, New Invader

TABLE 3 – 5. ASHLAND RANGER DISTRICT NOXIOUS WEEDS[9]

Summary by Ownership Within NFS Boundary

Common Name	Category[10]	USFS Gross	USFS Infested	Private Gross	Private Infested	State Gross	State Infested	Total Gross	Total Infested
Leafy Spurge	1	89.8	9.9	0.5	0.1	0.5	0.1	91.7	10.1
Spotted Knapweed	1	6414.7	191.7					6414.7	191.7
Canada Thistle	1	13.3	0.7					13.3	0.7
Russian Knapweed	1	181.3	20.0					181.3	20.0
Field Bindweed	1							0.0	0.0
Houndstongue	1	12.5	1.7					12.5	1.7
Dalmatian Toadflax	1								
Yellow Toadflax	1								
Oxeye Daisy	1								
Sulfur Cinquefoil	1								
Salt Cedar	2	0.9	0.1					0.9	0.1
Common Tansy	2								
Common Crupina	3								
Common Mullein	Roadside Weed	0.9	0.1					0.9	0.1
Musk Thistle	Roadside Weed								
Perennial Sow Thistle	Roadside Weed								
Other									
Total		**6713**	**224**	**0.5**	**0**	**0.5**	**0**	**6714**	**224**

TABLE 3 – 6. ASHLAND RANGER DISTRICT NOXIOUS WEEDS

Ashland Noxious Weed Acreage Summary by County (USFS ownership only *)

Common Name	Category	Rosebud Gross	Rosebud Infested	Powder River Gross	Powder River Infested
Leafy Spurge	1	8.4	1.1	81.4	8.8
Spotted Knapweed	1	33.8	1.4	6380.8	190.3
Canada Thistle	1	12.1	0.5	1.2	0.2
Russian Knapweed	1			181.3	20.0
Field Bindweed	1				
Houndstongue	1	12.5	1.7		
Dalmatian Toadflax	1				
Yellow Toadflax	1				
Oxeye Daisy	1				
Sulfur Cinquefoil	1				
Salt Cedar	2	0.9	0.1		
Common Tansy	2				
Common Crupina	3				
Common Mullein	Roadside Weed			0.9	0.1
Musk Thistle	Roadside Weed				
Perennial Sow Thistle	Roadside Weed				
Other					
Total		**68**	**5**	**6646**	**219**

[9] As Of 6-15-2004

[10] Category 1, Wide Spread, Category 2, Rapid Spreading, Category 3, New Invader

Appendix E depicts weed treatment priorities commonly utilized on the Custer National Forest due to a shortage of funding and effectiveness potential. Priority is generally given to those new populations of aggressive invader species where long-term management can be successful. An example would be a new site consisting of five plants of sulfur cinquefoil. On larger, well established infestations, such as many acres of leafy spurge, where long term effectiveness is questionable, containment strategies play a much more important role, such as in the Powder River Breaks on the Ashland Ranger District. Even then control emphasis is provided along the spread vector areas such as trailheads, roadways, and parking areas.

WEED BIOLOGY

Due to the large number of species identified as a weed to the CNF, a detailed discussion of the biology and ecology of each species is not provided here. Appendix I provides further biological features of common weed species on or near the Custer NF. Much more detailed information can be found in the project file. There are a number of species that are of particular concern to this analysis and these are discussed below in more detail.

Category 1 - Widespread Invaders

Species in this category are already widespread in and around the project area. These species have been here for decades yet are still increasing their range; some steadily and others rapidly. Current Category 1 invaders in and around the project area are:

Leafy Spurge (*Euphorbia esula*) - Leafy spurge is a long-lived, deep-rooted perennial that reproduces vegetatively and by seeds. The most distinguishable part of leafy spurge is a milky, latex fluid found in every part of the plant.

Leafy spurge can cause serious environmental damage by completely dominating a site and excluding all other species. It prefers grasslands and open gravel river bottoms. There are large infestations in and adjacent to the project area. Leafy spurge is known to occur on the Beartooth, Ashland, and Sioux Districts.

Spotted Knapweed (*Centaurea maculosa*) –Spotted knapweed is a biennial or short-lived perennial varying from eight inches to 4 feet tall with a stout tap root. The stout taproot, pink flowers tipped with white, and noticeable dark spots on the bud are what makes spotted knapweed different from the creeping-root form of Russian knapweed.

Spotted knapweed can cause serious environmental damage by completely dominating a site and excluding all other species. This species, for the most part, is restricted to non-forest environments and disturbed areas such as roadsides and gravel pits. Spotted knapweed is known to occur on the Beartooth, Ashland, and Sioux Districts.

Houndstongue (*Cynoglossum officianale)* – Houndstongue is a biennial growing 1 to 4 feet tall and reproducing by seed. It forms a rosette the first year and sends up a flowering stalk the second year. The nutlets break apart at maturity and cling to clothing or animals.

Houndstongue tends to grow in coulees, trees and brushy areas and fairly shaded sites, although not limited to, this environment. Houndstongue is known to occur on the Beartooth, Ashland, and Sioux Districts.

Canada thistle (*Cirsium arvense*) **–** Canada thistle is a creeping perennial that reproduces by seeds and fleshy, horizontal roots. The erect stem is hollow, smooth and slightly hairy, 1 to 5 feet tall. Sharp spines are numerous on the outer edges of the leaves and on the branches and main stem of the plant.

Canada thistle is usually found in open areas with moderate or medium moisture conditions. It is found most frequently in colonies along roadsides and railroad rights-of-way, and on rangeland, forestland, cropland, and abandoned fields. It is also found on stream banks, lakeshores, and other riparian areas.

Canada thistle is probably the most widespread of all thistle species, and thus is considered by many to be the most difficult to control. Canada thistle is known to occur on the Beartooth, Ashland, and Sioux Districts, especially in wildfire areas, prescribed burn areas, and timber harvest areas.

Sulfur cinquefoil (*Potentilla recta*) - Sulfur cinquefoil is a perennial, 1 to 1.5 feet tall, with well-developed rootstocks. Flowers are light yellow with 5 petals, each flower producing numerous single-seeds. Sulfur cinquefoil is a very aggressive plant and will grow and crowd spotted knapweed.

This is a relatively new invader to our area. First recorded in the 1980s, it has rapidly increased and now is widespread throughout the Beartooth foothills, mostly in disturbed non-forest environments. It can also be found in isolated spots in undisturbed settings. This plant is found largely in the project area within the Beartooth District.

Dalmatian Toadflax (*Linaria dalmatica*) – Dalmatian toadflax is a creeping perennial that closely resembles yellow toadflax, but is taller and can grow 2 to 4 feet in height, and the leaves are heart-shaped, clasping the stem. It is a deep-rooted (6 feet +), short-lived perennial that reproduces by seeds and by vegetative buds on the roots. The toadflaxes are easily distinguished from other rangeland weeds by the distinctive resemblance to domestic snapdragon.

Dalmatian toadflax is especially well adapted to arid sites and can spread rapidly once established. It is highly competitive where summer moisture is limited. It is found on the Beartooth Ranger District.

Yellow or Common Toadflax (*Linaria vulgaris*) – Yellow toadflax is a creeping perennial that closely resembles Dalmatian toadflax, but is shorter, growing only 12 to 30 inches tall, and the leaves are linear rather than heart-shaped. Like Dalmatian toadflax, yellow toadflax also resembles the snapdragon in appearance. Generally, yellow toadflax is found on moister, more fertile sites than Dalmatian toadflax. It is a deep-rooted (3 feet plus), short-lived perennial that reproduces by seeds and by vegetative buds on the roots.

Yellow toadflax has now become a serious problem to higher elevation rangelands and mountain meadows. Yellow toadflax is known to occur on the Beartooth District.

Oxeye Daisy (*Chrysanthemum leucanthemum*) – Oxeye daisy is an erect rhizomatous perennial, 10 to 24 inches tall. Leaves progressively reduce in size upward on the stem.

Oxeye daisy can be found in meadows, roadsides, and waste places. Oxeye daisy is known to occur on the Beartooth District.

Common Tansy (*Tanacetum vulgare*) – This species is an aromatic perennial. Stems are 1 ½ to 6 feet tall. It reproduces from seeds and rootstalks. Common tansy is sometimes mistaken for tansy ragwort.

Common tansy is generally found along roadsides, water areas, stream banks, and in pastures. It has long been used as a medicinal herb. Common tansy is known to occur on the Beartooth District.

Whitetop (*Lepidium draba*) – Whitetop is a creeping perennial which reproduces by seed and creeping roots. The extensive root system spreads horizontally and vertically with frequent shoots arising from the root stock. Lateral roots eventually turn down to become vertical roots which often reach greater depths than the parent roots. Both the vertical and lateral roots produce adventitious buds, which develop into rhizomes and shoots. The deep root system and the weed's ability to reproduce vegetatively make these weeds very difficult to control.

Whitetop, or hoary cress, is found on cultivated lands, along roadsides, in pastures, rangelands, and other non-crop areas. It grows in waste places, cultivated fields, and pastures, and is capable of vigorous growth on the irrigated, alkaline soils. Whitetop is known to occur adjacent to the Beartooth District.

Field Bindweed (*Convolvulus arvensis*) – Field bindweed is a perennial with an extensive root system. It often climbs or forms dense tangled mats. Stems are prostrate, 1 to 4 feet long.

Because of its remarkable adaptability to different environmental conditions, field bindweed may be found from low to high altitudes. Field bindweed is found on the Beartooth Ranger District.

Russian Knapweed (*Acroptilon repens)* –Russian knapweed is much like spotted knapweed in its appearance and flower color, except Russian knapweed has pale egg-shaped flowerhead bracts. Unlike spotted knapweed, Russian knapweed is a creeping perennial that forms dense colonies and is much more lush in appearance.

Russian knapweed grows in cultivated fields, along ditch banks, fence rows, roadsides, and in waste places. It invades open, disturbed ground, suppresses growth of surrounding plants and once established, forms a single species stand. It is considered a noxious weed in 412 counties within 21 western states. It is a serious habitat invader because of its aggressive nature and allelopathic properties. It is very poisonous to horses. It is especially prevalent from 4,500 to 7,500 feet.

Russian knapweed is known to occur in trace amount on the Ashland Ranger District and adjacent to the Beartooth Ranger District. It is found from the East Bridger to Warren area between the Pryor and Beartooth Mountains.

Diffuse Knapweed (*Centaurea diffusa*) – Diffuse knapweed is an annual, biennial, or short-lived perennial that can grow to a height of 3 feet, with a single, much-branched stem that gives the plant a bushy appearance.

Diffuse knapweed spreads by seed, aided by the tumbling of windblown mature plants, and it grows under a wide range of conditions. Diffuse knapweed is known to occur adjacent to the Beartooth Ranger District in trace amounts on the Shoshone and Gallatin National Forests.

Common St. Johnswort (*Hypericum perforatum)* – St. Johnswort is a hardy perennial weed that reproduces vegetatively and by seed.

It invades grassland habitats readily, but can also be found along roadsides in our moist forest environments. This species is highly valued as a medicinal herb and is being commercially harvested in large quantities. St. Johnswort is known to occur adjacent to the Beartooth Ranger District.

Category 2 - New Invaders

These species are known to occur in and around the project area, but have only recently invaded, so are still limited in geographic extent. Some are restricted to even smaller areas such as one river drainage, or meadow. Some of these species are not noticeably increasing, while others are exhibiting exponential growth. If left unchecked, most of these species are expected to transition into Category 1 in the near future. Category 2 species in and around the CNF are:

Absinth Wormwood (*Artemisia absinthium)* –Absinth wormwood, a perennial, grows 16-48 inches tall with relatively large dissected leaves that are 1.25 to 3 inches long.

This species is not listed on the Montana or South Dakota Noxious Weed List, but it is listed locally as a species of concern by Carbon County, MT and Harding County, South Dakota.

This species is often mistaken for a sagebrush variety of plant. This plant is very aggressive. It likes soil disturbance and will grow in most any type soils and tends to be in areas with moisture. Most common places to find absinth wormwood are gravel pits, topsoil stockpiled areas, new roads or construction sites, and irrigation ditch banks. Livestock and wildlife will not graze this plant due to the odor. Wormwood is known to occur adjacent to the Beartooth, Ashland, and Sioux Ranger Districts.

Orange Hawkweed (*Hieracium aurantiacum)* – Orange hawkweed is a fibrous rooted perennial forb up to 12 inches tall. The plant contains milky juice. Yellow hawkweed (*H. pratense*) is similar in appearance to orange hawkweed. This plant forms a solid mat on the ground choking out all grasses around it. It spreads similar to a strawberry and by seed dispersal.

The distribution of this species is limited. It is reported to be west of the Cascades. It is found in areas in Western Montana. This species was recently discovered in Carbon County near Luther. This species is known to occur on the Beartooth Ranger District.

Meadow Hawkweed Complex (*Hieracium pratense, H. floribundum,* and/or *H. piloselloides)* – These three yellow-petaled species are referred to as the meadow hawkweed complex. They have been highly successful at spreading because of their ability to reproduce by seeds, rhizomes, stolons, and adventitious root buds.

Meadow hawkweed tends to grow in places such as meadows, roadsides, pastures, lawns, and fields. Meadow hawkweed is known to occur on the Beartooth Ranger District in the Pryor Mountains, East Rosebud, and West Rosebud areas.

Dyer's Woad (*Isatis tinctoria*) – Dyer's woad is a winter annual, biennual or short-lived perennial. It has thick taproots and lateral roots. It adapts to dry areas and spreads primarily by seed. This species is not known to occur on or near the Custer National Forest.

Perrenial Pepperweed (*Lepidium latifolium)* - The perennial pepperweed is an aggressive weed that establishes and colonizes very fast. It usually grows from 1 to 3 ft. and sometimes up to 6 ft. tall. It is known to be a problem on the roadsides, rangeland, cropland to riversides or on mountain tops. This species is not known to occur on or near the Custer National Forest.

Purple Loosestrife (*Lythrum* species) – Purple loosestrife is a stout, erect perennial aquatic and wetland plant. Its invasion into a wetland system results in suppression of the native plant community and the eventual alteration of the wetland's structure and function. Loosestrife crowds out native vegetation and eventually becomes a virtual monoculture. Infestations appear to follow a pattern of establishment, maintenance at low numbers, and then dramatic population increases when conditions are optimal.

Unlike most invaders, this species grows in wetlands where it can completely dominate the vegetative cover and replace diverse native wetland communities. Purple loosestrife is a popular ornamental plant, commonly referred to as "lythrum." Purple loosestrife is known to occur in Carbon County, adjacent to the Beartooth District.

Tall Buttercup (*Ranunculus acris*) – Tall buttercup is a hairy perennial; often reaching 3 feet in height.

Buttercup species usually occur in meadows and pastures and are generally avoided by livestock. It has been reported to cause livestock poisonings. Tall buttercup is known to occur adjacent to the Beartooth Ranger District.

Tansy Ragwort (*Senecio jacobaea)* - Tansy ragwort's stem stands straight up and branches out at the top. This plant is a biennial plant, it sprouts in late fall or early winter. These plants get to about 6-feet high, with yellow colored flower petals numbering about 13 petals each. This plant when eaten by livestock can cause liver cancer and eventual death. Once eaten by the organism, the harmful materials and toxic milk stay in the organism's system and build up over time. This species is not known to occur on or near the Custer National Forest.

Saltcedar (*Tamarix* species) – Saltcedar is a deciduous or evergreen shrub or small tree, 5-20 feet tall. Bark on saplings and stems are reddish-brown. When given the chance, this tree can dry up complete waterways. As the water level lowers, the root system follows and continues to draw water. The plant transpires and lets off salt therefore the name "salt cedar." This salt kills non-salt tolerant plant life around it and turns the soil sterile to native plants.

Saltcedar is found along streams, canals, and reservoirs in much of the west. A few locations are known on the Ashland Ranger District. It also exists adjacent to the Beartooth Ranger District along the Clarks Fork River from Belfry to Laurel and east of Bridger on Bridger Creek near the Pryor Mountains.

Category 3 - Potential Invaders

Only one of these species is located in the project area (common crupina on the Sioux Ranger District). They are, however, either known from nearby areas or are expected to invade our area in the near future, based on their rapid rate of spread in our direction. Many of these species have caused severe ecological damage in other areas. Examples of significant Category 3 invaders near the project area are:

Yellow Starthistle (*Centaurea solstitialis)* - Yellow starthistle is a winter annual and is 2 to 3 feet tall.

Yellow starthistle grows on various soil types and is usually introduced on roadsides and waste areas. "Chewing disease" results when horses are forced to eat the yellow starthistle.
It has been discovered in alfalfa plantings in Carbon County (Joliet and Bridger) and is suspected in Rosebud County. It prefers drier habitats than typically occur on the CNF; however, the driest portions of the Forest are still at risk.

Rush Skeletonweed (*Chondrilla juncea)*- Rush skeletonweed is a long-lived perennial. It infests waste areas and areas of well drained sandy or rocky soils of dry to moist environments, although healthy native vegetation has been found to be more resistant to infestation. This species is not known to occur on or near the Custer National Forest.

Common Crupina (*Crupina vulgaris*) – Common crupina is a fall geminating annual. Crupina has rough, short, stiff spines on its leaves.

Crupina is found in range and disturbed non-crop lands. It can be found on southern slopes in steep canyon grasslands. Crupina has been documented on the Sioux Ranger District.

Yellowflag Iris (*Iris pseudacorus*) – Yellowflag iris is a herbaceous perennial wetland species that reproduces from seeds and vegetatively by rhizomes. It forms large dense colonies. It grows in wet areas and in water up to 10 inches deep. This species is not known to occur on or near the Custer National Forest.

Eurasian Milfoil (*Myriophyllum spicatum*) – Erasian milfoil is an emergent, herbaceous aquatic plant that reproduces vegetatively by rhizomes and fragmented stems. It forms large, floating mats of vegetation on the water surface, preventing light penetration. Red flowers bloom near the water surface. This species is not known to occur on or near the Custer National Forest.

NATIVE PLANT COMMUNITIES: VULNERABILITY TO INFESTATIONS - RATE OF SPREAD

Since the late 1800's exotic plant species have been spreading across the Pacific Northwest and Northern Great Plains. It is clear when studying distribution records of exotic plant species over time that the plants are increasing and expanding their range once they are established (Rice 1999). Based on these historic trends, these patterns of expansion will continue due to transport of seeds from increasing intercontinental travel and trade, and through continued disturbance on all lands (through agricultural, residential, recreational, and commercial developments). Nationally, Forest Service lands have an estimated six to seven million acres that are infested with noxious or invader weeds. This figure is increasing at an exponential rate of 8-12 percent per year. For example, 10 acres of spotted knapweed left unmanaged today in a disturbed environment has the potential of increasing to 1,000 acres in ten years.

Invasive species have been recognized as being second only to land development in the loss of biodiversity. Some exotic species are so fast to colonize and convert native vegetation that little can be done in time to stave off the invasion. A review of the timing of action taken to address the threats from these species has shown that action often comes too late. Many species are not recognized and placed on noxious weed lists until they have already caused irreparable harm. To remedy this problem, researchers and managers have recently moved towards developing more proactive approaches, such as analyzing the risk of exotic species to the environment. Evaluating risk to native plant communities from

invasion by the most imminent and threatening of exotic plant species is important in identifying opportunities for action.

The 1.2 million acres of Custer National Forest land supports a very diverse mixture of plant communities. Vegetation runs from open, dry grasslands and sagebrush/grass in the valley bottoms, to dense lodgepole, subalpine fir and Douglas fir forest in the mid elevations. Subalpine/alpine grasslands, tundra and rock barrens dominate the high elevations. Wetlands and riparian areas are scattered throughout the Forest.

Forested vegetation dominates the majority of the lands on the Beartooth District, while the Sioux and Ashland Districts are composed of about half forested and half non-forested systems. However, the areas dominated by non-forest vegetation encompass the highest species and plant community diversity. Some of these areas are also at the greatest risk for invasion by exotic species.

Alpine vegetation: Alpine communities occur at the highest elevations along the Beartooth Mountain Range. These communities are highly significant from a diversity standpoint, because they serve as refugia for arctic/alpine species that are topographically isolated from one another. Consequently, a number of rare native species and local endemics (plants that grow nowhere else in the world) can be found there. Although exotic species can occur on these sites, these communities are not at risk by the species currently identified as invaders because these sites are incompatible for the growth and establishment of the invader species.

Grasslands (steppe) and Shrub-steppe: A shrub-steppe is a grassland, co-dominated by shrubs, such as shrubby cinquefoil or sagebrush. These are sites that are not favorable to tree growth (usually not enough moisture), where grass species or a combination of grasses and shrubs dominate. Although there is not a great deal of acreage in these communities on the CNF, they are important from a species diversity perspective. They are also at the greatest risk from exotic species invasion, because environmental conditions in these vegetation types are very similar to the conditions where many invader species originated.

Nearly all of the montane and foothill grasslands found on the CNF outside the Absaroka-Beartooth Wilderness are classified in the Idaho fescue/bluebunch wheatgrass habitat type (Mueggler and Stewart 1980). These are typically found on warm (southerly aspect), well-drained sites at all elevations throughout the Forest. Dominant species are Idaho fescue and bluebunch wheatgrass, however, many other native grasses and forbs can be found. Many of these communities on the CNF are currently free of invasive species; however, with any degree of disturbance or introduction of exotic seeds, these sites are highly at risk.

In the Absaroka-Beartooth Wilderness, drier plant communities are minor components of the designated area. Idaho fescue grasslands are found.

Wetlands and Riparian Communities: Plant communities dominated by moisture-loving plants occupy a small fraction (about 25,000 acres – less than 5%) of the total landscape on the CNF. However, these sites have the greatest species diversity of all vegetation communities in our area. Many different types of wetlands exist, including sedge, bulrush or cattail dominated marshes; grass or sedge dominated wet meadows; fens, and peat land. Riparian areas are those stringers of vegetation along stream courses that are highly influenced by the high water table adjacent to the flowing water. Species composition on these sites is highly variable, but tends to be shrub dominated with willows, red-osier dogwood and alder. Riparian / Wetlands are at risk from exotic species invasion. Some wetlands tend to out-compete many invasives, while other riparian areas in a drier setting are at higher risk to invasion.

Currently, Canada thistle can be deleterious to native wetland and riparian communities. A trace amount of inventoried weeds are found in riparian systems (mostly Canada thistle). Protection measures in Appendix C and label instructions address riparian / wetland concerns. Other wetland/riparian weeds include poison hemlock, purple loosestrife, reed canarygrass, tall buttercup, and water milfoil.

Canada thistle is also widespread, growing in dense colonies of disturbed wet meadows and riparian areas. Purple loosestrife and reed canarygrass has been found in adjacent lands within Carbon County,

Montana. Poison hemlock is known to occur on the Ashland District. Tall buttercup and water milfoil have not been found in any wetland or riparian environments in or near the project area.

Although leafy spurge is not considered a moisture-loving plant, it can flourish in well-drained river cobbles and gravel bars along stream courses.

Forested Plant Communities: Most closed canopy environments of common forest types found on the Custer National Forest are not conducive to invasion and infestation by exotic species. Even those species that can flourish in a forest setting need more sunlight, some degree of disturbance, or a combination of the two. However, in more open and / or disturbed conditions, nearly all but the wetland/riparian invaders can occur.

Many invader species are more successful in the more open canopy, drier forest types (dominated by Douglas fir or ponderosa pine), especially when there is some type of disturbance such as a road, skid trail, livestock grazing, or high recreational use. On the CNF, the most noticeable and widespread invaders in this situation are spotted knapweed, houndstongue, Canada thistle, dalmatian toadflax, and leafy spurge. Other species, however, are rapidly spreading such as sulfur cinquefoil.

Table 3 - 7 quantifies the acreage at risk of invasion if the current weed populations are allowed to grow unchecked. Some of the associated sites are already infested with early pioneering plant species making them prime candidates for weed spread. Approximately 45% percent or roughly 550,000 acres is naturally susceptible or at high risk to weed invasion in the project area.

TABLE 3 - 7. COVER TYPE VULNERABILITY TO WEED INFESTATION[11]

(figures in **Bold** print considered most at risk)

Cover Type	Beartooth			Sioux	Ashland	CNF.
	Ac. Over 8000'	Ac. Below 8000'	Total Ac.	Total Ac.	Total Ac.	Total Ac.
Non-irrigated Ag Land		**60**	60	**429**	**1261**	1750
Irrigated Ag Land		**15**	15	**318**	**2521**	2854
Non-native Grassland		**1037**	1037	**883**	**2956**	4876
Very Low Cover Grassland	20572	**11983**	32555	**2002**	**66436**	100992
Low / Moderate Cover Grassland	51317	**27030**	78347	**73460**	**117433**	269240
Moderate / High Cover Grassland	2020	**7367**	9387	**29972**	**21549**	60909
Open Canopy Sagebrush 5-25%			0	**427**	**7993**	8420
Closed Canopy Sagebrush >25%			0	**96**	**16132**	16228
Mesic Shrublands	6558	**2260**	8818	**3596**	**27571**	39985
Xeric Shrublands - Sagebrush		**6960**	6960			6960
Horizontal Juniper			0	12		12
Aspen	125	**8657**	8783			8783
Mixed Broadleaf / Cottonwood		**1058**	1058	**10470**	**4536**	16064
Lodgepole Pine	11223	36273	47496			47496
Whitebark Pine	41645	**4968**	46613			46613
Limber Pine	234	**12549**	12782			12783
Ponderosa Pine Closed Canopy >25%	26	1372	1398	35309	170452	207159
Ponderosa Pine Open Canopy <25%		**1300**	1300	**13615**	**22092**	37007
Douglas Fir Closed Canopy >25%	1525	28975	30500		3356	33856
Douglas Fir Open Canopy <25%		**5990**	5990			5990
Rocky Mtn. Juniper			0	**371**		371
Utah Juniper		**1300**	1300			1300
Douglas Fir / Lodgepole Pine	2898	21696	24594			24594

[11] Acreage is within NF Boundary and includes private and state inholdings. Based on Silc3bnd04 Grids (postfire version CNF cover types).

Cover Type	Beartooth			Sioux	Ashland	CNF.
	Ac. Over 8000'	Ac. Below 8000'	Total Ac.	Total Ac.	Total Ac.	Total Ac.
Douglas Fir / Ponderosa Pine		347	347			347
Subalpine Fir / Spruce	38590	15683	54273			54273
Mixed Subalpine Conifer	55		55			55
Mixed Upper Subalpine Conifer	2410	14	2424			2424
Mixed Lower Subalpine Conifer	1772	10620	12392			12392
Mixed Xeric Conifer	97	4099	4196			4196
Water	2479	1207	3686	69	442	4197
Rock	112283	7013	119296	1298	9023	129617
Mines / Quarries		154	154			154
Grass Dominated Badlands			0	**3277**	**12048**	15325
Shrub Dominated Badlands			0	**635**	**15781**	16416
Snow	23919	36	23995			23995
Acreage Over 8000'	319748					
Acreage Below 8000'		220023				
Entire Unit Acreage			539771	176240	501580	1217594
Acreage Vulnerable to Weeds (taken from figures indicated in Bold print)		**92534**		**139552**	**318308**	**550394**
Vulnerable Acreage % of Unit		**17%**		**79%**	**63%**	**45%**

The degree of risk from some of the most threatening species can be evaluated when completing project risk assessments using the Northern Region protocols outlined in Appendix D. The susceptibility of an area to species' establishment, the level of threat to susceptible areas, and the probability of exposure of each site to plant propagules affecting dispersal can be evaluated. Overlaying weed inventories with this vulnerability assessment can further identify areas that are potentially at risk from invasion.

Ground disturbing catastrophic events, such as a wildfire, create an environment most prone to the spread of noxious weeds. Weeds typically establish most quickly on previously forested areas having burned under high intensity and high severity conditions. Prior to recent large wildfires, shading by conifers inhibited noxious weeds from spreading into areas with unburned overstories. The large wildfires that occurred on the Custer National Forest (1988 Storm Creek, 1992 Blank, 2000 Stag/Tobin, 2001 Willie, and 2003 Red Waffle and Kraft Springs) opened the overstory forest canopy and reduced understory vegetation on about 22% of the Custer NF landscape which allowed a prime seedbed for competing weeds. Post-fire monitoring indicates a definite increase in the number of weeds, especially Canada thistle, Spotted Knapweed, and Leafy Spurge following the fires. These large scale fire areas are most prone to long-term invasion.

POISONOUS PLANTS

Tall Larkspurs (*Delphinium occidentale and D. barbeyi*) – Some plant species can be considered an undesirable even though they are native to the area. Tall larkspur, especially where conditions support it becoming a major component of the landscape, can be poisonous to cattle. Management of these sites often occurs where significant poisoning occurs. There is an economic loss associated with livestock poisoning from tall larkspur. Additional financial losses associated with poisonous plants include: reduced weight gains, increased management costs (i.e. labor, veterinary, fencing, etc.), and control costs. Poisoning on rangelands occurs with irregularity because of changes in climatic conditions.

Among all of the poisonous plants, tall larkspur causes a large number of cattle deaths on western ranges (USDA, ARS, 1998, USDA, ARS, 2000, USDA, ARS, 2001. Tall larkspur claims average death losses of 4-5% annually in some areas in Utah, Colorado, Wyoming, Idaho and Montana. Some ranchers experience death losses of more than 15% (Ralphs et al., 2003). Tall larkspur causes poisoning in June and July, depending on the elevation. At lower elevations the plant material is not considered poisonous after August 15. Some cattle death losses on the Beartooth District are attributed to tall larkspur.

The principle poisoning agent is found throughout the tissue of young larkspur, and concentrates in the reproductive parts of the plant as the plant matures. In mature plants, only the seeds are considered poisonous (Ralphs et al., 2003).

As a result, the presence of tall larkspur on many rangelands forces livestock operators to avoid some pastures early in the season. An avenue of control is herbicides. The entire taproot and underground buds must be killed, or it will regrow the next year. Total eradication is nearly impossible, but reducing larkspur density can significantly lower the amount eaten and reduce death losses.

Current management practices include deferring livestock entry into tall larkspur areas until plants become more mature and less toxic. This minimizes permittee economic loss due to livestock fatality from poisoning. However, due to variability in seasonal precipitation, population densities, livestock behavior, and timing of actual plant maturity, livestock losses still occur. This equates to an economic loss that can be further minimized through control of tall larkspur populations in primary rangelands under permit. Sheep grazing, fertilizing, and grazing avoidance during the early summer months, and herbicides have all proven effective.

Tall larkspur is a member of the buttercup family and it stands from two to six feet tall. The flowers are deep blue of purple and have the characteristic spurs of the delphinium flower group. Tall larkspur is found in the foothills of the Rocky Mountains, growing in moist draws or coulees and on hillsides at higher elevations. Larkspur needs some shade and a well-drained, fertile soil.

Tall Larkspur is abundant in moist mountain settings along the Beartooth front on the Beartooth Ranger District. It is responsible for cattle losses over the years, especially in the Pass Creek and Picket Pin areas.

Picloram (Tordon), Metsulfuron (Escort), Glyphosate (Roundup), and triclopyr (Garlon 4) control tall larkspur (USDA, FS, FEIS database 2003). Picloram (Tordon) is effective on tall larkspur and can be used throughout the growing season. Metsulfuron (Escort) works well during the early stages of growth, but is less effective as larkspur matures. (Ralphs, 1995). Glyphosate (Roundup) can be selectively applied by hand spraying or with a wipe-on applicator to kill larkspur in the bud stage. However, it is not as effective after the plants have flowered. Reinvasion and re-establishment of tall larkspur proceed slowly due to slow growth and development of seedlings and juvenile stages. After herbicide treatment, tall larkspur may have a period of about 15 years before it again reaches potentially dangerous levels relative to livestock poisoning (Cronin, 1976 and Ralphs, 1995).

Keeping cattle off herbicide treated areas until plants are completely dead and dry is recommended. Larkspur's toxicity and palatability may actually increase after the plants are sprayed. To be safe, cattle should be kept off the area for the remainder of the grazing season (USDA Poisonous Plant Research Laboratory, 2003).

Use of ammonium sulfate fertilizer to control patches of tall larkspur is another method available under the proposed action (cutting to ground level and applying 1/2 cup to base of each tall larkspur, cutting to 10 inch height and applying ¾ cup at the base of each tall larkspur, or no cutting and applying one cup at the base of each tall larkspur). 100% mortality occurred in study plots in Lone Spring Butte in Northwestern Colorado (9,400 ft. elevation, 25 inches precipitation per year, in soils predominantly from shale origin) the first year after application. Long-term results, nine years after application, indicated no tall larkspur. Additionally, some other broadleaf forbs treated were not found nine years post treatment, while some broadleaf forbs remained. However, the main plants identified in the treatment plots were native perennial grasses (Clementson, 1999).

For spot treatment, there are advantages for using ammonium sulfate fertilizer compared to herbicide treatment. They include (Clementson, 1999):

- The fertilizer is granular so it is easy to pack into areas of difficult access or rough terrain.
- The fertilizer can be purchased at any local feed store.
- There is no requirement for a certified applicator.

- The application method is simple and easy to learn.
- The cost of application is less than the cost of the application of herbicides.
- As with herbicide control, larkspur mortality occurs within one year and continues for many years.
- With the addition of a weed eater, the application rate can be reduced by up to 50%, which could ultimately lead to a cost savings.
- Areas cut with a weed eater die the same season they are treated, allowing for grazing to occur in the immediate area without further threat of livestock loss from poisoning.
- Application of the fertilizer does not appear to adversely affect nearby vegetation in the area.

OTHER UNDESIRABLE PLANTS

Areas of land used for transportation, utilities and other services include paved roads; helibases, drainage culverts, special use permits such as telephone and electric transmission lines; and ditches can have undesirable vegetation growing in or adjacent to them. Undesirable plants may increase maintenance costs of the infrastructure (i.e. plants encountered in pavement cracks that can cause pavement crumbling and deterioration), be a safety problem, or cause injury.

Paved roads. Less than 5 acres along paved roads on the Beartooth District (see Table 3 – 8) may need periodic treatment to reduce pavement deterioration from vegetation growth (predominantly grasses). Pre-treatment with glyphosate is helpful to reduce existing vegetation. This can be followed up by treating a foot from the shoulders' edge or on other hairline fractures with herbicides such as diuron or diuron and sulfometuron methyl mix.

TABLE 3 – 8. TREATABLE ACREAGE OF PAVED ROADSIDES

Road #	Road Name	Treatable Acres[12]
2071	West Fort Rock Creek	1.17
2071C	Basin Creek Campground	0.10
2087	Red Lodge Ranger Station	0.01
2177	East Rosebud	0.92
2346	Lake Fork	0.42
2379D	Westminster Spires	0.01
2400	Stillwater Trailhead Road	0.23
2400A	Woodbine Campground Entrance Road	0.06
2400B	Woodbine Campground First Loop Left	0.13
2400C	Woodbine Campground Second Loop Left	0.05
2400D	Woodbine Campground First Loop Right	0.08
2400E	Woodbine Campground Second Loop Right	0.05
2421	Main Fork Rock Creek	0.22
2421A	Upper Parkside Campground	0.11
2421B	Limber Pine Campground	0.08
2421D	Greenough Lake Campground	0.13
2421F	Lower Parkside Campground Loop	0.07
2846	West Fork Stillwater	0.05
	Grand Total	3.89

Special Use Permits: Approximately 910 acres of the 1066 acres under special use permit have a higher likelihood for localized disturbances where weeds are likely to periodically occur or where there is a need for vegetative maintenance. It is estimated that less than 5 acres would need annual integrated pest management treatment.

TREATMENT METHODS

The goal of integrated pest management is to manage undesirable plants in such a manner that management objectives are maintained and adverse side effects are minimized. Various management techniques can be effective. Treatment methods by Alternative are described in Chapter 2 and their

[12] Acres determined using the assumption that herbicide treatment for paved road maintenance would consist of up to one foot from the edge of each side of the paved road length.

effectiveness in Appendices F and J. Methods include mechanical, cultural, biological, and chemical. Existing uses of these methods occur to varying degrees on the Custer NF, although herbicide use has been the primary treatment method. Table 3 - 9 summarizes some key points regarding the treatment methods.

TABLE 3 – 9. SUMMARY OF TREATMENT METHODS

Treatment Method	Discussion/Considerations
Cultural Control	
Competitive Seeding	Most effective after weed populations have been reduced by other control actions.
Grazing Animals	Must match the species with the appropriate grazer for best success; treatment must occur during proper phenological stage; herding required; sometimes nonselective.
Fertilization	Could improve the success of desirable species; may be limited depending on species/soil characteristics.
Manual / Mechanical Control	
Mowing-Weed Whipping	Limited to level and gently sloping smooth-surface terrain. Must be conducted for several consecutive years; treatment timing critical.
Hand-Pulling /Grubbing	Labor intensive; not effective on deep-rooted or rhizomatous perennials; causes ground disturbance that may increase susceptibility of site to reinvasion by weeds; effective on single plants or small, low-density infestations.
Prescribed Fire	Variable effectiveness. Most use has been in grassland restoration. May cause resprouting or stimulated germination of the treated vegetation. Most effective in combination with other treatments
Biological Control	
Parasites, Predators, and Pathogens	Most effective when integrated with other strategies; does not achieve eradication; not effective on all invasive plants; long term process required.
Herbicides	
Ground Application	Not cost-effective on steep slopes; application timing limited based on plant phenology and weather conditions. Most appropriate for small, relatively accessible infestations and areas where controlling off-site drift is critical.
Aerial Application	Potential for off-site drift must be considered; application timing limited based on plant phenology and weather conditions. Most appropriate for large, relatively inaccessible infestations

CULTURAL TREATMENTS

Cultural methods of noxious weed management are generally targeted toward enhancing desirable vegetation to minimize weed invasion. Planting or seeding desirable species to shade or out-compete weeds, applying fertilizer to desirable vegetation, and controlled grazing are common cultural treatments.

Cultural treatments would occur on sites where the native vegetation lends itself to this type of treatment. Most of the other weed sites have an adequate source of native plants and do not require additional seeding with native species. Less than 5 acres of isolated areas are anticipated for cultural treatment at this time. However, future areas may have the need for this type of treatment, for example, reclaiming gravel pits, decommissioned roads, or well pads.

Seeding

The National Strategy for Invasive Species Management (2004) for the Forest Service also encourages the use of native species in rehabilitation and restoration. It encourages the shifting of restoration projects from the use of invasive non-natives to other less invasive and native species.

Forest Service Manual 2523.2 under Watershed Protection and Management sets priorities for burned area emergency response treatments stating that natural recovery by native species is preferred. It states that when practical, use seeds and plants in these project areas that originate from genetically local sources on native species or when native materials are not available or suitable, give preference to non-native species that meet the treatment objectives, are non-persistent and are not likely to spread beyond the treatment area.

When seed is introduced to a site by non-natural means (e.g., seeding by humans), there is a risk of introducing non-native and/or invasive species. Use of certified weed-free seed is required and reduces

this risk. The magnitude of the risk varies and may be determined by seed source, cleaning practices, and other factors. Certified weed free seed has tolerances for certain weed species and is only certified free of certain weed species (Montana Weed Act Section 4.12.3010-11).

Invasive weeds are often able to establish and occupy a site relatively quickly after introduction because native species are typically slower to germinate and establish. Seedling establishment of native species depends on proper seeding depths, soil, adequate soil moisture, prior removal of as many invasive weeds as possible, and often exclusion of livestock (Goodwin and Sheley, 2001). Use of mulching and/or barriers to travel paths in high use areas can also make this treatment more effective.

Selection of a native versus non-native seed mix depends on management objectives. If the objective is naturalness in a plant community dominated by less competitive species, native mixes would be used. Non-native species may be more appropriate where erosion control and competition with invasive weeds are the objective. A compromise is to include short-lived, non-native, less dominant species mixed with native seeds. On many National Forest sites, there is adequate residual native and desirable vegetation under the invasive weed canopy such that re-vegetation is not necessary. Once the invasive weeds are removed, individual vegetation can respond and often results in dense, competitive, and desirable vegetation communities.

Numerous annual or sterile cereal grasses could be used instead of the above persistent non-natives. For example, cereal wheat, barley, annual ryegrass or sterile wheatgrass have been used in restoration efforts. In the case of wildfire recovery, some studies are being done to assess the success of seeding with these species. Keeley (2004) found that seeding with cereal wheat, at high seeding rates, reduced invasive species after two years. The study also found decreases in species richness and ponderosa pine seedlings. The dense stands of wheat did appear to reduce erosion, but left thick thatch which increased fire hazard at least initially. Such studies suggest determining if seeding is necessary and the amount of seed per acre considered crucial for reducing disruption to ecosystem processes.

Attempts to replace cheatgrass with perennial grasses can be difficult. Efforts to remove cheatgrass will require filling the interspaces between the plants. This requires seeding shallow rooted species such as sandberg bluegrass, Sherman big bluegrass, or covar sheep fescue. The perennial plant cover in a stand of cheatgrass is generally less than five percent. A successful weed treatment seeding would occur if the perennial species establish a groundcover of 15 to 25 percent.

Attempts to replace smooth brome, Kentucky bluegrass, timothy grass, or crested wheatgrass with other native perennial grasses can be difficult and would require significant investment for several years of combined treatments. Combined treatments could include grazing, mowing, burning, herbicide treatment, and plowing, etc., followed up be seeding, fertilizing, and/or mulching. Restoration of native vegetation in these areas dominated by these exotics is not an easily attainable objective. Given the nature of these environments, particularly in large scale landscapes such as occurs on the Custer NF where these species are already well established, full restoration of native vegetation may be an unreasonable objective. Thus, until other technologies have been examined and proven effective, goals for restoring native flora in these areas should remain conservative.

Grazing

Grazing can be an effective management tool on several weed species. Since grazing animals prefer certain forage, selective use of forage can shift competitive balance of plant communities. For example, goats and sheep have been used in various areas for controlling knapweed and leafy spurge. Controlled, repeated grazing of spotted knapweed by sheep has been found to reduce the number of one and two year old spotted knapweed plants within an infestation (BIRC). Appropriate grazing by animals preferring weeds can shift the plant community toward more desired grasses (Stannard, 1993). Conversely, grazing can also selectively reduced grass competitiveness, shifting the community in favor of weeds.

Use of grazing animals as a weed management tool must be based on selecting the appropriate grazer (cattle, sheep, or goats) for the target weed. Managers must also determine when, how much, and how often to graze animals to have maximum impact on the weeds with minimum impact on desirable species. Use of grazing animals as a weed management tool on roadsides, trailheads and larger infestations on the

Forest is limited due to factors associated with maintenance and management of the animals. A long-term commitment to small ruminant grazing is necessary for effective weed control and achievement of desired results. Invasive weeds can compensate quickly after the grazing pressure is removed because of their dormant seeds in the soil, and because they can rapidly increase flower stem and seed production once grazing pressure is removed.

Many of the areas proposed for weed treatment still have relatively viable native plant communities intermixed with the weed invaders. Vulnerable landscapes are dynamic plant communities that are constantly being shaped by the process of succession. Successful restoration should compliment successional processes. Grassland species evolved with grazing, and in many cases, grasses require defoliation every two to four years to remove old stems that shade plants and hinder growth. Defoliation methods, such as grazing, mowing or burning stimulate grass growth and enhance its competitive ability. However, proper grazing management is essential in maintaining long-term objectives for weed management. Most weedy species are well adapted to invade heavily grazed areas, allowing competitive advantage.

Grazing animals can be used to assist in weed control efforts, but in most cases will not eradicate mature infestations when used alone. Sheep and goat grazing is being considered under all alternatives however there are some major concerns. For example small ruminant animals are at risk to predation from wolves and bears, and there is the risk of transmitting disease from domestic sheep to bighorn sheep. Initial use of sheep and goats will require protection measures to ensure that predation and disease transfer do not occur. Also, both the animals and the experience will need to be gained from commercial practitioners.

Grazing management considerations are important in assisting with the restoration of native grasslands. Timing and frequency of cattle grazing can be adjusted to minimize impact on grasses. Permittees are authorized to graze livestock on National Forest System lands by permit. The General Terms and Conditions of the grazing permit, part 8(b) and (c) allow for annual adjustments as deemed necessary by the Forest Service, to coincide with resource protection measures. This could include restoration measures essential for achieving long-term effectiveness of weed treatment programs.

Grazing Knapweeds: Grazing knapweed stands with sheep and goats can suppress knapweeds (IPMPA, 2000. http://www.efn.org/~ipmpa/Noxknapw.html). Continual grazing of the tops of young plants can retard plant development, seed formation, and gradually deplete root reserves. Since animals usually prefer to eat nearby grasses in lieu of knapweeds, grazing is most effective against knapweeds when the livestock is enclosed in a fenced-off, weedy area. Animals will not graze on Russian knapweed when other vegetation is available because of its bitter taste (Stannard, 1993).

Spotted knapweed is more palatable in late spring or early summer and repeated grazing can reduce flower stem production. Diffuse knapweed seed production can be reduced when grazed during the bolting stage for 10 days, and again after 14 days for an additional 10 days. Although grazing diffuse knapweed can reduce seed production, it can also cause diffuse knapweed to become a short-lived perennial and when grazing is removed, populations often return to its former levels (DiTomaso, 1999).

Goats and sheep are economical and they do not pose the environmental dangers of applying chemicals. In addition to their value for weed control, sheep can also be used for income from the sale of their wool. If confined, Angora and Spanish goats will trample or browse virtually any vegetation within a fenced area. Desirable trees or shrubs can be protected with light-weight flexible fencing reinforced with electrified wire.

Grazing impacts should be considered on biocontrols, if present. Long-term grazing can be detrimental to seedhead insects because of the removal of seedheads. Also, grazing can delay flowering times and cause asynchrony between the insect and knapweed life cycle. Grazing is compatible with root feeding biocontrols.

Grazing Leafy Spurge: Sheep and goats provide an alternative to herbicides for controlling leafy spurge top growth in pasture and rangeland. Grazing alone will not eradicate leafy spurge but will reduce the infestation, slow the spread of the weed, and allow grasses to be grazed by cattle and horses. Grazing should be started early in the spring when the plant first emerges. On large infestations, pastures should be divided so animals can be regularly rotated and the entire infestation grazed in a timely manner.

Sheep and goats are best suited to control leafy spurge on large infestations, or along waterways and tree areas where chemical control is restricted or cost is prohibitive. North Dakota State University (NDSU) research has shown that grazing leafy spurge with goats followed by a fall applied herbicide treatment provided better leafy spurge control than either method used alone. The goats were allowed to graze until mid-August, then removed to allow 3 to 4 inches of leafy spurge regrowth. Then Tordon plus 2,4-D was applied at 0.5 plus 1 pound per acre in mid-September. Leafy spurge density was reduced over 95 percent when this program was followed for three consecutive years.

Recommended stocking rates vary with terrain, leafy spurge density, and rainfall during the growing season. Sheep should be grazed at approximately three to six head per acre of leafy spurge per month or one to two ewes per acre of leafy spurge for the summer. North Dakota State University research using Angora goats found that 12 to 16 goats per acre of leafy spurge per month or three to four goats per acre of leafy spurge for four months (growing season) controlled leafy spurge with little utilization of the grass species. The stocking rate will decline over time as the leafy spurge infestation is reduced. Prevention of flowering and seed-set by leafy spurge is important. Before moving animals to a leafy spurge free area, they should be contained for three to five days so viable seed can pass through the digestive system (NDSU, 1995. http://www.ext.nodak.edu/extpubs/plantsci/weeds/w866w.htm).

MECHANICAL TREATMENTS

Weeds can be treated by various mechanical methods such as hand pulling, prescribed burning, mowing, and tilling. Pulling weeds by hand, would probably be the primary mechanical treatment method on the CNF and would occur on particularly sensitive areas, or areas of small infestations. Hand pulling is not very effective on plants that spread via roots because the soil needs to be excavated repeatedly to remove all root fragments. Sites less than a tenth acre with non-rhizomatous species and low weed density could be hand pulled. On some sites herbicides can be used in conjunction with pulling to help reduce plant density so that pulling is cost efficient.

Mechanical weed management methods can be effective on small infestations. Hand pulling and hoeing are the oldest and most traditional weed management methods. These methods are labor intensive and relatively ineffective for management of large, dense infestations of perennial noxious weeds. Best results are achieved when the entire root is removed on non-clonal species. This is not always possible when treating deep rooted or rhizomatous weeds. Hand pulling often leaves root fragments that generate new plants. Hand pulling also causes disturbance that may increase susceptibility of the site to reinvasion. While this control method is effective on single plants or relatively small infestations, it is not economically feasible on large, well-established knapweed infestations. In addition, hand pulling plants that contain toxins or skin allergens can expose individuals to their poisonous effects (DiTomaso, 1997 and 1999).

Test plots established on Blue Mountain (Lolo National Forest) and the Lee Metcalf National Wildlife Refuge near Stevensville, Montana, measured effects of hand pulling on spotted knapweed. On the two sites spotted knapweed covered 76 percent and 53 percent, respectively. Average pulling cost for the two locations was calculated at $8494 per acre per year and is used to estimate and analyze pulling costs. Hand pulling provided 100 percent flower control and 56 percent plant control at Blue Mountain, but increased bare ground from 2.7 percent to 13.7 percent during the first year after treatment (USDA, FS 2005).

Mowing and tilling (such as discing or plowing) prevent plants from producing seeds when treated in the bud stage or earlier. Efforts repeated every 21 days during the growing season can deplete the underground food supply of some perennials. These methods would be required for at least a three-year period to attain satisfactory control. These methods would also weaken non-target species in treated areas.

Mechanical treatments such as tillage are most applicable to tap-rooted weed species; this method can be used on small acreages, level terrain, and infestations that are "tended' or visited on a regular basis in order to remove new plants and re-sprouts as they occur. Tillage removes all vegetation and must be combined with seeding or planting of desirable species. Although mechanical treatments can reduce seed

production for the treated season, invasive weed seeds may remain viable in the soil for several years (Stannard 1993; Messersmith et al., 1985). Re-infestation of a site from residual seed, especially when disturbed, will often occur without continued follow-up treatment. Tilling would be considered only in areas where slope is less than 10 percent and a small percentage of the vegetation consists of shrubs.

In most cases, endemic native species do not appear capable of out-competing invasive weeds. On appropriate sites, herbicide application after weeds have emerged, followed by tillage and drill seeding, can be an effective treatment for establishing desirable species. This process, however, can lead to increased soil compaction (DiTomaso, 1999), and cannot be conducted on steep, remote, and rocky sites, characteristic of most sites on the Forest.

Mowing or cutting is more effective on tap-rooted perennials such as spotted knapweed compared to rhizomatous perennials. Cutting or mowing plants can reduce seed production, if conducted at the right phenological stage. For example, a single mowing at late bud growth stage can reduce the number of seeds produced by spotted knapweed (Duncan et al.). Mowing can also weaken the competitive advantage of weeds by depleting root carbohydrate reserves. Because of large carbohydrate reserves, mowing must be conducted several times a year for consecutive years to reduce the competitive ability of the weed.

Because invasive weeds flower throughout the summer, it is difficult to time mechanical treatments to prevent flowering and seed production. Repeated mechanical treatment too early in the growing season can result in a low growth form that is still capable of producing flowers and seed (DiTimaso 2001, Goodwin and Sheley, 2001). Mechanical treatments on some rhizomatous weeds, such as leafy spurge, can encourage sprouting and result in an increase in stem density (Goodwin and Sheley, 2001).

Mulching with plastic or organic material can be used on relatively small weed infested areas (less than ¼ acres), but will also stunt or stop growth of desirable native species. Mulching prevents weed seeds and seedlings from receiving sunlight necessary for survival, and can smother some established weeds. Although hay mulch was used in Idaho to reduce flowering of Canada thistle (Tu et al., 2001), most rhizomatous perennial weeds cannot be controlled by this method because their extensive root reserves allow re-growth through or around mulch.

The most effective prescribed fires for controlling invasive plant species are typically those administered just before flower or seed set, or at the young seedling/sapling stage. Sometimes prescribed burns that were not originally designed to suppress an invasive species have had a good side effect. But in some cases, prescribed burns can unexpectedly promote an invasive, such as when their seeds are specially adapted to fire, or when they re-sprout vigorously. These prescriptions must be modified or other management actions taken to undo or reverse the promotion of the invader.

Most successful weed control efforts that result from burning are due to the restoration of historical (natural) fire regimes, which had been disrupted by land use changes, urban development, fire breaks, or fire suppression practices. Many prescribed burn programs are, in fact, designed to reduce the abundance of certain native woody species that spread into unburned pinelands, savannas, bogs, prairies, and other grasslands. Repeated burns are sometimes necessary to effectively control weedy plants, and herbicide treatments may be required to kill the flush of seedlings that germinate following a burn.

Burning can be implemented when weather or fuel conditions are favorable, usually between March and November and only at times approved by state organizations responsible for smoke management. Burning permits will be obtained where required. An air quality analysis was not conducted. Prescribed burning on any sizeable scale is unlikely due to the biology of the weeds being addressed in the analysis; therefore emissions are not of concern. If prescribed fires are used as a tool, smoke management considerations will be addressed during the development of the burn plan. Any classified airsheds (Class I and II areas – Northern Cheyenne Indian Reservation, AB Wilderness Area, and Yellowstone National Park) will be identified and compliance with state implementation plans and state smoke management plans will be evaluated.

All burning would be conducted in accordance with Custer National Forest fire management policy which requires the site specific preparation of a prescribed burn plan before every burn. The prescribed burn

plan addresses the objectives of the burn, physical characteristics of the burn area, type of fuels, weather conditions under which the plan will be carried out, expected fire behavior, air and water quality restrictions, ignition pattern and sequence, emergency fire control workforce requirements, public contacts, and safety.

The most common methods are hand-held fusees and drip torches and are applied directly to the vegetation. When using hand-carried drip torches or fusees, individuals cross the area in a specified pattern described in the prescribed burn plan. Tailoring traverse patterns to each area identified to be treated can maintain effectiveness, maximum safety, and control.

BIOLOGICAL CONTROL TREATMENTS

Biological control agents include the use of insects or pathogens to consume or kill select portions of individual weeds, reducing growth or reproduction of the weed. See Appendix I for species-specific biological controls available.

Biological weed management is the deliberate use of natural enemies (parasites, predators, or pathogens) to reduce weed densities. Natural enemies and competitive vegetation prevent weed species from dominating other species. Non-native invasive weeds are such a problem, in part, due to the lack of natural enemies.

Biological management is self-perpetuating selective, energy self-sufficient, economical, and well suited to integration of an overall weed management program (DiTomaso, 1999). Management with biological agents is a slow process that does not achieve eradication. Biological agents may be ineffective if they are not integrated into other strategies. Currently, there are strict standards met before biological control agents are approved. About 29 percent of the biological management efforts in the United States have demonstrated some level of success (DiTomaso, 1999).

A weed infestation may increase in density and area faster than the newly released biocontrol agent population; therefore, other control methods must be used in conjunction with the release of biocontrol agents. The perimeter of the infestation may be sprayed to keep the weeds from spreading.

Various federal and state clearances are required for the release of any biocontrol agent in the states of Montana and South Dakota. Existing and newly approved biological controls could be introduced where appropriate. Some of the biological control agents in use are: Canada thistle stem weevil (*Ceutorhynchus litura*), knapweed seed head gall flies and knapweed flower weevil (*Urophora affinis, U.quadrifasciata,* and *Larinus minutus*), knapweed root feeding insect (*Agapeta zoegana*, and *Cyphocleonus achates*); leafy spurge flee beetles (*Aphthonia czwalinae, A. flava, A. nigriscutis,* and *A. lacertosa*); toadflax stem boring beetles (*Mecinus janthinus*); and toadflax seed head beetles (*Gymnetron linariae* and *Brachypterolus pulicarius*) and a defoliating moth (*Calophasia lunula*).

Leafy spurge has a biological control agent that can substantially reduce plant density in a wide variety of sites. Sites with both large number of acres (more than 25 to 50 acres) and with weed species that have an effective biological control agent available will be managed with biological control. Spotted knapweed and musk thistle have also been greatly reduced by biological control agents. Since biological control agents are usually very slow to establish and will never eradicate its host, these sites will need to be contained with the use of herbicides for the most effectiveness.

Biological control is becoming more important where actual eradication or control is not likely. The best defense has been one of attacking weeds from every angle possible. While some agents can reduce weed densities by as much as 30 to 40 percent, none have eliminated a weed completely. Some agents require a number of years to become established and have a significant effect on weed populations. Efforts to establish insectaries will continue as the biological control program develops more options. Use of these biological control agents are generally targeted for larger infestations, rather than isolated trace infestations. Therefore, not all infestations are good candidates for biological control efforts.

Biological control agents are chosen for their host specificity (i.e., they are designed to target only a particular weed species). In this sense they are useful in native plant communities because they avoid other non-target vegetation.

In order to assure that agents considered for bio-control are host specific, the Animal and Plant Health Inspection Service (APHIS) has designed a rigorous screening process which includes testing agents proposed for release on a representative group of native plant species, including plants that are similar taxonomically. Particular attention is paid to related threatened, endangered, and sensitive plant species. Because of the remote possibility of effects to native plants from bio-control agents, the CNF may consider new releases on the Forest.

Biological control agents have been periodically released on the CNF between 1993 and 2003. Black leafy spurge flea beetles (*Aphthona nigriscutis*) have been released on the Ashland (two releases) and Sioux Ranger Districts (five releases). Some effectiveness of these releases has been observed.

HERBICIDE TREATMENTS[13]

Use of herbicides for weed treatment involves application of products developed, labeled and produced to treat weed species at certain stages of plant growth. Herbicides considered in this analysis include: 2, 4-D, aminopyralid, chlorsulfuron, clopyralid, dicamba, diuron, glyphosate, hexazinone, imazapic, imazapyr, metsulfuron methyl, picloram, sulfometuron methyl, and triclopyr. Ammonium sulfate (fertilizer), an herbicide adjuvant, is also considered in this analysis as an effective herbicide for use on tall larkspur. Several herbicides are considered because they vary in effectiveness on different weeds.

The length of time each herbicide controls invasive weeds varies with the type of herbicides, environmental conditions, and target weeds. Some herbicides control weeds for a short time, while others can provide a few years of control from one application. The U.S. Environmental Protection Agency approved herbicide labels include safe handling practices, application rates, and practices to protect human health and the environment. A description of herbicides including copies of labels, susceptibility of weeds to different herbicides, Material Safety Data Sheets (MSDS), and guidelines proposed for use on the Project are contained in the Project Record. Herbicide labels and MSDS information can be found at http://www.greenbook.net/search/QuickList/ .

One feature of the proposed action alternative is the flexibility to use current and updated agents as they are registered and approved by the EPA. All herbicides will be applied according to label specification; or when additional protection measures are required by Forest Service policy as described in this chapter. Impacts on soil and water will be mitigated to meet State laws and Pesticide Application Requirements, Northern Region Soil and Water Standards, and Custer Forest Plan Standards. Appendix G lists the herbicides addressed in this document, and their associated target weed species. See Appendix F for species and herbicide specific effectiveness information.

Herbicide selection would be based on environmental conditions such as groundwater depth, soil type, non-target vegetation, and management objectives. Appendix I displays examples of herbicides proposed for use and a range of application rates. Herbicide selection considers the following criteria:

- Herbicide label considerations;
- Herbicide effectiveness on target weed species;
- Proximity to water or other sensitive resources;
- Soil characteristics;
- Potential unintended impacts to non-target species such as conifers or shrubs;
- Application method (aerial-broadcast, ground-spot, ground-broadcast, or wick application);
- Other weed species present at the site, and effectiveness of herbicides on those species (for example spotted knapweed infestations with inclusions of toadflax);
- Adjacent treatments (private land);
- Timing of treatments (spring/fall); and
- Priority weeds – new invaders vs. existing.

[13] Refer to Chapter 5 Glossary for terms and concepts about herbicides.

Herbicides, like biological control agents, go through an extensive screening and testing process before they are registered and approved for use, by the U.S. EPA. Initial pesticide registrations with the EPA typically require a minimum of 120 tests, take seven to ten years to complete, and cost between $30 and $50 million. Herbicide labels have the force of law and include safe handling practices, application rates, and practices to avoid undesirable impacts to humans and the environment.

Safe application methods and practices would minimize health risks to applicators and forest visitors, and protect native vegetation, wildlife, and watersheds. All chemicals would be handled within Forest Service Handbook 6709 and 2109 guidelines and the EPA label restrictions included with each type of herbicide for storage, mixing, application, and disposal methods.

Application of herbicides to treat weeds would be performed by, or directly supervised by, a State licensed applicator following all current legal application procedures administered by the Montana or South Dakota Department of Agriculture.

A spill plan (included in Appendix M) will be utilized to reduce the risk and potential severity of accidental spills. This plan identifies methods to report and clean up spills.

All herbicide label restrictions and procedures would be followed, as approved by the Environmental Protection Agency (EPA). These labels are the laws governed by federal and state agencies. Labels contain information for the proper administration of each herbicide and cover such items as a list of the ingredients, EPA registration number, precautionary statements (hazards to humans and domestic animals, personal protective equipment, user safety recommendations, first aid, and environmental hazards), directions for use, storage and disposal, mixing and application rates, approved uses, inherent risks of use, limitations of remedies, and general information. Herbicides would also be applied in accordance with directions specified in Forest Service Handbooks 6709 and 2109.

Herbicide treatments would include both ground and aerial herbicide applications, in compliance with the protection measures listed in this document. Chemical applications would take place at the appropriate time of year for targeted weed species and incorporate environmental considerations as outlined in Chapter 2 protection measures. Equipment such as helicopters, trucks, ATVs, horses, backpack sprayers, and other hand held application equipment will be used.

Following the Adaptive Management Strategy (see Appendix E), other herbicides may be used when they become available if they are permitted by the EPA, have a human health and environmental risk assessment completed per direction of Forest Service Handbook 2109.14, Chapter 10, and are registered for use by the states of Montana or South Dakota.

Surfactant adjuvant would be used in certain situations to increase efficacy, primarily on target species with a waxy cuticle (especially toadflax), or when temperature and humidity are not optimal (but still within label and more locally-prescribed limits) yet other conditions, such as plant phenology, are ideal. Surfactants may be used during periods of drought. Surfactants proposed for use will follow the same protection measures as picloram. Only those labeled for use in and around water would be used within 50 feet of water, or the edge of sub-irrigated land, whichever distance is greater, or on high run-off areas. Some surfactants are labeled for use in and around water including Activate Plus ®, LI-700 ®, Preference ®, R-11 ®, Widespread® and X-77®.

Areas with aerial applications would also include ground applications, to treat buffer areas and skipped areas. These areas are typically estimated at 5 to 10 percent of the aerial treatment acres. Based on monitoring, follow-up aerial and ground treatments are expected to occur on third and fifth years after initial treatment, as portions of the dormant seed or root system propagate. Based on previous experience with weed treatments, it is likely that the treatment areas would then enter “maintenance mode” where spot treatments of infestations would continue to occur until weeds are eradicated. Aerial application will not be in designated wilderness areas, research natural areas, or near sensitive areas (such as near water or sensitive plant populations). Sites identified for aerial treatment are either not accessible by roads (previous roads have been decommissioned) or have steep slopes which make walking difficult.

All herbicide applicators, including Forest Service or contractor employees, will follow label instructions and protection measures. A field inspector will be on-site during all aerial applications to monitor drift and compliance with label specification. Label information is available in the Project File and at http://www.fs.fed.us/foresthealth/pesticide/index.html , an Environmental Health Reference and Resource Materials website.

Ground applied herbicide treatments would occur in areas where there is good access, a manageable size of infestation, and available funding. See Appendix C for Protection measures by Alternative.

THE DECISION TO USE HERBICIDES

The choice of whether an herbicide is used over other control methods would be based on integrated weed management principles. Decisions would be made based on whether other methods or combination of methods are known to be effective on the species in similar habitat. The choice of herbicide would be based on the undesirable species; how it reproduces, its seed viability, the size of its population, site conditions, known effectiveness under similar site conditions and the ability to mitigate effects on non-target species.

In most cases, if an herbicide is selected, it would be used in combination with other methods. For example, initial treatment on an undesirable species may be done by an herbicide, but then manual or mechanical methods would be implemented as maintenance treatments over the long term. Large established populations would be less apt to undergo herbicide treatment. Such populations may be controlled at their perimeters to maintain "weed-free" zones or may be candidates for biological control. The focus of any herbicide treatment would be on the species of highest concern where the negative effects can be mitigated.

Application methods used would be based on site accessibility. Aerial spraying, for example, would only be used in areas where access is remote and difficult and/or populations are of the size that non-herbicide methods or selective herbicide application are not feasible.

Herbicide treatment consists of applying chemicals, usually of a manufactured or synthetic origin, to a plant or to soil. The plant absorbs the herbicide through roots, leaves, or stems. The herbicide interferes with plant metabolic processes, stopping growth and usually killing the plant. A suite of available herbicides is needed to help meet the variety of long-term site goals and address the complex resource issues at the Forest level. Different herbicides vary in effectiveness and length of control on different invasive plants. Herbicides also vary in their effects to the environment and suitability to different environmental conditions.

Herbicides vary in their environmental activity, physical form, and the equipment used to apply them. In combination with other site and biological factors, these characteristics influence both the probability of meeting site-specific goals for weed control, and the potential of impacting non-target components of the environment. Soil properties impact the effectiveness of weed treatment and restoration actions as well.

Herbicides may be selective or non-selective. This means they control all types of vegetation (non-selective), or they selectively control either some broadleaf plants or grasses while not affecting others (selective). Some herbicides may control only actively growing vegetation at the time of application, or they may provide undesirable species control through root uptake from the soil (short-term to over a few years). In soil and water, herbicides may persist or decompose by sunlight, microorganisms, or other environmental factors.

Herbicides vary in selectivity of control for various plant groups. Those differences in selectivity are the basis for developing effective weed control prescriptions while minimizing adverse effects and facilitating native plant community maintenance or restoration. Another variation among herbicides is the duration of control of the target undesirable plants. Label application restrictions can also limit the number of herbicides available to control any site-specific undesirable plant infestations.

Physical form of herbicides varies. Some may be oil- or water-soluble molecules dissolved in liquids, or attached to granules for dry application to soil surface. Herbicides may move from their location of

application through leaching (dissolved in water as it moves through soil), volatilization (moving through air as a dissolved gas), or adsorption (attached by molecular electrical charges to soil particles that are moved by wind or water).

Herbicides may be applied with a variety of equipment and techniques. The techniques vary in effectiveness, environmental effects, and costs. Helicopters or fixed-wing aircraft are used for aerial application of sprays or granules for rapid broadcast coverage of large or inaccessible areas.

Herbicides may be sprayed via ground vehicles with hose sprayers or booms using an array of spray nozzles. This equipment is most commonly used for broadcast spraying of roads, but can also be used on all-terrain vehicles for broadcast or spot spray in remote areas.

Some application equipment is often used for selective treatment and/or to minimize non-target effects. Backpack sprayers are most frequently used to spray the foliage, stem, and/or surrounding soil of target undesirable plants. Other equipment includes herbicide-soaked wicks or paintbrushes for wiping target vegetation, and lances, hatchets, or syringes for injection of herbicide into stems of target plants. Granular herbicides may be applied using hand-held seeders, or other specialized dispensing devices.

Each herbicide is sold as one or more commercial products, called formulations. The product label for herbicide formulation provides legally binding direction on its use, including safe handling practices, application rates, and practices to protect human health and the environment.

Foliar Herbicides are often used for the control of herbaceous plants and small trees and shrubs. Brush can be defoliated with foliar herbicides to improve access for soil or trunk treatments, but foliar herbicides are normally not recommended for the larger brush species because the potential for drift is too great when tall species are sprayed. The applicator should operate the spray gun from the ground and with a hose of sufficient length to be able to treat from a position close to the plants.

Herbicides that are applied after the emergence of a crop or a weed are referred to as post-emergence. Herbicides that are applied before the emergence of a crop or a weed are referred to as pre-emergence. They may be either selective or nonselective and either contact or systemic, depending upon the herbicide used. Selective herbicides kill some kinds of plants but have little or no effect on others.

The use of selective herbicides allows the removal of unwanted weeds from desirable plant communities. 2, 4-D is a selective herbicide that removes broadleaf weeds but will not injure grasses. Nonselective herbicides kill all vegetation. Examples are diuron (Karmex) and glyphosate (Roundup, Accord).

Contact herbicides do not move readily in the plant and usually only kill the part of the plant they touch. Contact herbicides are most effective when applied to actively growing plants before flowering. They kill most annual weeds but do not provide any residual control; thus, a new flush of weeds may germinate from seed after an herbicide application. Contact herbicides also will burn off the top-growth of perennial weeds (e.g., Canada thistle), but these weeds will usually re-sprout from underground parts. Because contact herbicides fail to prevent later germination of annual weeds and only burn off the top-growth of perennials, they have limited importance in right-of-way situations.

Systemic herbicides are absorbed through plant top-growth or plant roots and interrupt critical physiological processes necessary for plant growth. They move into and throughout the plant as long as the plant is actively growing. They are of particular value in their ability to control established perennial weeds.

The effectiveness of some foliar treatments will be reduced if rain falls shortly after application. The ester formulations of 2,4-D are absorbed in 1 to 2 hours, whereas 6 to 8 hours are required for adequate absorption of dicamba, glyphosate and 2,4-D amine formulations. Thorough wetting of the leaves and stems to the point of runoff is essential for some foliage treatments to be effective (see Appendix J for rainfastness).

The label may suggest that an adjuvant (see Appendix J), such as a surfactant, be added to the herbicide to improve its activity. These chemicals allow the herbicide to spread over more leaf surface so that more

herbicide can be absorbed. Use of an adjuvant may be necessary for better absorption by foliage that is extremely waxy or hairy. The activity of systemic herbicides, such as 2,4-D, is also increased when they are applied along with a surfactant. Increased activity of selective herbicides may result in severe injury of desirable plants, so additives should not be added in all situations. Label guidelines should be followed.

Soil Applied Herbicides. Some herbicides move through the soil to the root zone, where they are absorbed. Others are absorbed by the shoots of emerging seedlings as the plant grows through the herbicide layer in the soil. Soil-applied herbicides are either selective or nonselective; they range in residual activity from none to several months. Soil-applied herbicides are formulated as liquids, granules, or pellets. Granules and pellets can be applied by hand shakers or by equipment such as rotary applicators, cyclone seeders, or other spinning-disk equipment. Even though granules drift less than do liquid sprays, their pattern of application from rotary applicators can be distorted by wind, resulting in an overdose in one area and under-application in another area.

However, some labels recommend that applications be made after the last hard frost in spring and before the first hard frost in autumn. A soil herbicide usually needs to be leached by rain into the soil where it can be absorbed by the plant root or shoot. It may take the herbicide several weeks to reach the roots of some deep-rooted plants. Injury symptoms will not appear until the plant has absorbed and translocated the herbicide. Symptoms from a late fall treatment may not be visible until the following spring.

Soil herbicides should not be applied in areas where they may leach into groundwater, or run off into water sources or cropping areas. Sandy soils have little adsorptive (binding) capacity, and may not hold the herbicide near the soil surface where most weed seeds germinate. Avoid making herbicide applications in areas where tree and shrub roots may extend. The recommended rates for soil-applied herbicides depend upon the weed species present, the soil texture (percent sand, silt, and clay) and the amount of soil organic matter.

Woody plants (i.e. Salt Cedar) are controlled by a number of different methods. Individual stem applications are used to apply herbicides directly onto or inside the stems of individual woody plants (trees or shrubs). Tree injectors, hack and squirt techniques, Hypo-Hatchets™ or similar devices, and cut stump treatments are used to deliver herbicides directly to the transport and growing tissues beneath the bark of woody plants.

Basal-bark treatments can be used to control brush, and to control trees up to 5 inches in diameter. They are useful to selectively remove undesirable brush species from stands of desirable plants. Basal-bark treatments are made with oil-soluble herbicides in a carrier of diesel oil, kerosene, or other carriers. The spray is applied to the lower 18 inches of the stems, and should thoroughly drench the stem, crown, and all exposed roots. However, care must be taken during application because most vegetative ground cover will be injured by herbicide applied in a diesel oil carrier. Where only a limited number of trees are to be controlled, a 3- to 5-gallon knapsack sprayer works well for the application of a basal-bark spray. Basal-bark applications made during the dormant season do not result in brownout of foliage, which may make dormant treatments desirable. In addition, since vapors from basal-bark applications may drift out of the treatment area, undesirable brush in areas adjacent to susceptible plants can be treated during the dormant season to reduce injury potential.

Herbicide application to cut surfaces in the bark of trees is an effective method for controlling woody species. Cut-surface applications are recommended when plants have thick bark or when they have stems greater than 5 inches in diameter. Applications can be made effectively during any season except in the spring during heavy sap flow. The cut must be made rapidly with a sharp saw or pair of pruning shears. A chain saw should be used on larger trees. The cut surface should be saturated with herbicide as soon as possible after cutting. On large tree trunks, the cambium area next to the bark is the most vital area to wet. The stump should be painted within a few minutes. Woody plants have a wound response that quickly seals the cut surface and restricts the movement of herbicide into the roots. The best results are achieved by treating woody perennials that are not water stressed and are growing actively. Common herbicides used for cut stump treatments include 2, 4- D amine, glyphosate, and triclopyr. Only the most concentrated herbicide formulations should be used for cut surface treatments.

Herbicide Drift

Spray drift is the direct movement of herbicide from the target to areas where herbicide application was not intended. Movement of spray droplets or herbicide vapor causes herbicide drift. Several factors affect spray drift and are defined below, the results of which are summarized in Table 3-10. Incorporating these factors into the project design protection measures (see Appendix C) will reduce the risk of drift. Appendix N displays aerial application models used in the analysis. An air quality analysis was not conducted for aerial application since protection measures include drift control measures and closing treatment areas for spray operations.

Spray Particle Size: Spray drift can be reduced by increasing droplet size, since large droplets move less than small droplets in wind. Reducing spray pressure, increasing nozzle orifice size, special drift reducing nozzles, additives that increase spray viscosity, and rearward nozzle orientation, all can increase droplet size.

Method of Application: Herbicide spray drift is generally greater from aerial application than from ground boom or broadcast application. Little or no drift occurs when spot treating by hand. Low-pressure ground sprayers generally produce larger spray droplets, which are released from the nozzle closer to the target than with aerial sprayers.

Distance Between Nozzle and Target: Less distance between the droplet release point (the boom arm) and the target reduces spray drift. The spray travels a shorter distance with less opportunity for drift.

Herbicide Volatility: All herbicides can drift as spry droplets, but some are sufficiently volatile to cause plant injury from drift of fumes.

Relative Humidity and Temperature: Low relative humidity and/or high temperature cause more rapid evaporation of spray droplets between the nozzle and target than high relative humidity and/or low temperature. Evaporation reduces droplet size, which in turn increase the potential drift of the spray droplets.

Wind Direction: Herbicides should only be applied when the wind is blowing away from non-target plants.

Wind Velocity: The amount of herbicide lost from the target area and the distance the herbicide moves will increase as wind velocity increase, so greater wind velocity will generally cause more drift.

Air Stability: Horizontal air movement is generally recognized as an important factor affecting drift, but vertical air movement is often overlooked. Vertical stable air (temperature inversion) occurs when air near the soil surface is cooler or similar in temperature to higher air. Small spray droplets can be suspended in stable air, move laterally in a light wind and impact plants downwind. Spray drift in vertically stable air can be reduced by increasing spray droplet size.

Spray Pressure: Spray pressure influences the size of droplets formed from the spray solution.

Nozzle Spray Angle: Spray angle is the angle formed between the edges of the spray pattern from a single nozzle. Nozzles with wider spray angles produce smaller spray droplets than those with narrower spray angle at the same delivery rate.

Nozzle Type: Nozzle types vary in droplet sizes produced at various spray pressures and gallons per minute output.

Air Movement around Aircraft: Vortices are irregular drifts of air around the fixed wing of airplanes or the rotary blades of helicopters. The fixed wing or rotor tips produce an updraft, while the body of the aircraft produces a downdraft. Vortices affect the deliver of spray particles accordingly.

TABLE 3 - 10. EFFECTS OF DRIFT FACTORS ON HERBICIDE DRIFT

Factor of Drift	More Drift	Less Drift
Spray particle size	Smaller	Larger
Release height	Higher	Lower
Wind Speed	Higher	Lower
Spray pressure	Higher	Lower
Nozzle size	Smaller	Larger
Nozzle orientation	Forward	Backward
Nozzle location	>3/4 wingspan	<3/4 wingspan
Air temperature	Higher	Lower
Relative humidity	Lower	Higher
Nozzle type	Small droplets	Large droplets
Air stability	Stable	Unstable
Herbicide volatility	Volatile	Non-volatile

MODE OF ACTION AND HERBICIDE FAMILIES

Herbicides that are chemically similar are said to belong to the same "herbicide family". The compounds in a given family typically exhibit similar characteristics and function, due to their chemical and structural similarities. For example, clopyralid, picloram, and triclopyr are all grouped in the pyridine family.

An herbicide is often chosen for use based on its mode of action. If one herbicide is ineffective, another herbicide with a different mode of action may provide better results. When and how an herbicide is applied may be determined by its mode of action.

An herbicide's mode of action is the biochemical or physical mechanism by which it kills plants. Most herbicides kill plants by disrupting or altering one or more of their metabolic processes. The mode of action is generally dictated by its chemical structure, and therefore, herbicides in the same family, tend to have the same Mode of Action. For instance, clopyralid, picloram, and triclopyr are all in the pyridine family and are all auxin mimic herbicides, while glyphosate is an amino acid inhibitor. Some herbicides from different families, however, can have the same mode of action. For example, the phenoxy 2,4-D is an auxin mimic, just like the pyridines picloram, clopyralid, and triclopyr. Animals typically suffer little or no effect from most herbicides sold today because these compounds principally affect processes exclusive to plants, like photosynthesis or production of aliphatic amino acids.

"Pre-emergent" herbicides are those applied to the soil before the weed germinates, and either disrupt germination or kill the germinating seedling. "Post-emergent" herbicides are those that are applied directly to established plants and/or soil. Some herbicides are effective both before ("pre-emergent") and after ("post-emergent") germination.

COMPARISON OF HERBICIDES

Appendix G and Table 3 - 11 lists the herbicides included in the analysis. These herbicides or formulations are registered by the EPA for use in forestry applications, right-of-ways, or rangelands and are appropriate for use against undesirable plant species in Montana and South Dakota. The characteristics listed are meant to give a general overview of the capabilities of each herbicide. More details on these herbicides can be found in the commercial labels provided on all EPA approved products. Vast information is available on undesirable plant control using resources from numerous authorities such as the State noxious weed programs or county noxious weed coordinators, Nature Conservancy, and number weed organizations (Project File).

The following table summarizes those herbicides and their properties that may be useful in treating undesirable plants when using an integrazted pest management approach.

TABLE 3 – 11. COMPARISON OF HERBICIDES[14]

Chemical/Brand Names/Mode of Action	Properties	General Uses/Known to be Effective on:[15]	Comparisons/Issues [16]
2,4-D / (Weedone, Weedar, many more) / *Synthetic auxin - Mimics natural plant hormones.*	Readily absorbed through leaves or roots. Accumulation is primarily in the young, rapidly growing meristematic regions of roots or shoots.	Readily absorbed and metabolized. Used for the control of many broadleaf species.	Half-life in soil is usually not longer than 1 or 2 weeks during the growing season due to rapid decomposition by soil micro-organisms. Amines and esters are the most common formulations of 2,4-D. The esters are the most active and can be used at the lower rates and for brush control. Since vapor drift is a potential problem with the ester formulations, only the amines should be used in susceptible lawn, garden, or crop areas. Low-volatile esters can be used in areas where risk of damage to sensitive non-target vegetation is low.
Aminopyralid / (Milestone) pyridine carboxylic acid *auxinic growth regulator - disrupts plant growth metabolic pathways*	Aminopyralid provides systemic postemergence control	Broad-spectrum control of a number of key noxious and invasive annual, biennial and perennial weed species, as well as agronomic broadleaf weeds. Aminopyralid can also provide residual weed control activity controlling re-infestations and reducing the need for re-treatment depending on the rate applied and the target weeds.	It provides broad-spectrum broadleaf weed control at very low labeled use rates (4 to 7 fl oz/acre, or 0.06 to 0.1 lb ae/acre), compared to currently registered herbicides with the same mode of action, including 2,4-D, clopyralid, triclopyr, picloram and dicamba. Can be applied up to the water's edge
Chlorsulfuron / (Telar,Glean,Corsair) / *Sulfonylurea-Interferes with enzyme acetolactate synthase w/ rapid cessation of cell division and plant growth in shoots and roots.*	Glean -Selective preemergent or early postemergent Telar – Selective pre- and post-emergent. Chlorsulfuron can be used for many annual, biennial and perennial broadleaf species.	Use at very low rates on annual, biennial and perennial species; especially Canada thistle, dalmation toadflax, hounds tongue and perennial pepperweed. Safe for most grasses.	Safe for most perennial grasses, conifers. Some soil residual. Potential for offsite movement through runoff or wind erosion is substantial in conditions that favor these actions. Damage to some aquatic plants possible at peak concentration. Without drift mitigation (selective spot hand treatment, etc.), offsite drift from ground broadcast application may cause damage to non-tolerant species up to 900 feet[17].
Clopyralid / (Transline) / *Synthetic auxin –Mimics natural plant hormones.* Similar to picloram. Contains hexachlorobenzene.	A highly translocated, selective herbicide active primarily through foliage of broadleaf species. Little effect on grasses.	Particularly effective on Asteraceae, Fabaceae, Polygonaceae, Solanaceae. Some species include knapweeds, yellow starthistle, Canada thistle, hawkweeds.	Not as persistent as picloram. Can persist from one month to one year. More selective than picloram. Potentially mobile depending on site specific conditions. Without drift mitigation (selective

[14] This table is a brief summary of some of the attributes of these herbicides. More information is provided in the species write ups or more information can be found from the references given.
[15] The information on effectiveness by species (third column) contains examples of just some of the species the herbicides can treat.
[16] Issues listed in this table and in following species-specific tables were identified in Forest Service Risk Assessments prepared by Syracuse Environmental Research Associates, Inc. Risk assessments are available at: http://www.fs.fed.us/foresthealth/pesticide/work.shtml
[17] **Off site drift may cause damage to non-tolerant plants.** Whether or not damage due to drift would actually be observed after the application would depend on a several site-specific conditions, including wind speed and foliar interception by the target vegetation. For example, in a right-of-way application conducted at low wind speeds and under conditions in which vegetation at or immediately adjacent to the application site would limit off-site drift, damage due to drift would probably be inconsequential or limited to the area immediately adjacent to the application site. Tolerant plant species would probably not be impacted by the drift and might show relatively little damage unless they were directly sprayed (SERA Risk Assessments).

Chemical/Brand Names/Mode of Action	Properties	General Uses/Known to be Effective on:[15]	Comparisons/Issues [16]
			spot hand treatment, etc.), off site drift from ground broadcast application may cause damage to non-tolerant species up to 300 feet.
Dicamba / (Banvel , Vanquish) *Synthetic auxin -Mimics natural plant hormones*	Readily absorbed by roots, stems or leaves and then translocated to other plant parts. Control is best when weeds are small and actively growing.	Used for the control of a variety of broadleaf and woody vegetation. Particularly effective against bindweed and Canada thistle.	Spray drift is toxic to non-tolerant plants in the same manner as 2, 4-D, thus similar precautions should be followed. Banvel is more likely to generate dicamba vapor than Vanquish. Dicamba is often mixed with grass herbicides or with phenoxy herbicides to provide a broader spectrum of weed control.
Diuron / (Karmex, Diurex 80W) / *Substituted urea; strong inhibitor of photosynthesis*	Most readily absorbed by roots, less so by foliage. Translocated upward in the xylem. Applied to crops as a preemergence or directed early postemergence spray, preferably before weed growth becomes dense. Better control of emerged weeds is obtained by the addition of a suitable surfactant. In non-crop areas, diuron may be sprayed anytime except when ground is frozen.	Used as a herbicide to control a wide variety of annual and perennial broadleaf and grassy weeds. Diuron is used on industrial sites, on rights-of-way, around buildings, and on irrigation and drainage ditches.	Should not be used where it is likely to leach or wash into contact with the roots of desirable trees or shrubs. Diuron is a highly persistent and fairly immobile herbicide. When applied to soil it will not leach below 5 to 10 cm from the surface.
Glyphosate / (RoundUp, Rodeo etc.) / *Inhibits three amino acids and protein synthesis.*	A broad spectrum, nonselective translocated herbicide with no apparent soil activity. Translocates to roots and rhizomes of perennials. Adheres to soil which lessens or retards leaching or uptake by non-targets.	Low volume applications are most effective. Control for purple loosestrife, reed canarygrass and other weeds common in wetland and riparian habitats.	Aquatic formulations can be used near water. Rain within 6 hours of application may reduce effectiveness. Complete control may require re-treatment. Without drift mitigation (selective spot hand treatment, etc.), off site drift damage from ground broadcast application to non-tolerant species up to 100' possible.
Hexazinone / (Velpar) Inhibits photosynthesis	Primarily soil-active; some foliar activity.	Broad spectrum control with some selectivity for conifers	Minimal volatility. Adsorbed by organic matter and clay; highly water-soluble with potential for leaching on sandy soils
Imazapic / (Plateau) / *Inhibits the plant enzyme acetolactate, which prevents protein synthesis.*	Selective against some broadleaf plants and some annual grasses.	Use at low rates can control leafy spurge, cheatgrass, and hounds tongue. Useful in grassland prairie habitat restoration because it is selective against annual grasses.	Without drift mitigation (selective spot hand treatment, etc.), off site drift from ground broadcast application may damage non-tolerant species up to 50' possible; over 100' if aerially applied. Even very tolerant species could be damaged directly. Some damage to aquatic plants at peak concentrations.
Imazapyr / (Arsenal, Chopper, Stalker, Habitat) / *Inhibits the plant enzyme acetolactate, which prevents protein synthesis.*	Broad spectrum, nonselective pre- and postemergent for annual and perennial grasses and broadleaved species.	Most effective as a postemergent. Has been used on cheatgrass, white top, perennial pepperweed, tamarisk, dyers woad, and woody species.	High potential for leaching. Highly mobile and persistent. Residual toxicity up to several years. May be actively exuded from the roots of legumes, likely as a defense mechanism by these plants.
Metsulfuron methyl / (Escort) / *Sulfonylurea –*	Selective against broadleaf and woody	Use at low rates to control such species as houndstongue,	Potentially mobile in water or through wind erosion. Damage to

Chemical/Brand Names/Mode of Action	Properties	General Uses/Known to be Effective on:[15]	Comparisons/Issues [16]
Inhibits acetolactate synthesis, protein synthesis inhibitor, block formation of amino acids.	species. Most sensitive crop species in the Lily family.	perennial pepperweed, sulfur cinquefoil. Safest sulfonylurea around non-target grasses.	some aquatic plants possible at peak concentrations. Without drift mitigation (selective spot hand treatment, etc.), off site drift from ground broadcast application may cause damage to non-tolerant plants up to 500'.
Picloram (Tordon) Restricted Use Herbicide Contains hexachlorobenzene.	Selective, systemic for many annual and perennial broadleaf herbs and woody plants.	Use at low rates to control such species as knapweeds, Canada thistle, yellow starthistle, houndstongue, toadflaxs, St. Johnswort, sulfur cinquefoil and hawkweeds.	Without drift mitigation (selective spot hand treatment, etc.), off site drift from ground broadcast application may cause damage to non-tolerant plants up to 1000'. Also can leak out of roots to non-targets. One application may be effective for 2 or more years. Can move offsite through surface or subsurface water. Can be relocated through livestock urine.
Sulfometuron methyl / (Oust) / *Sulfonylurea - Inhibits acetolactase synthase, a key step in branch chain amino acid synthesis.*	Broad spectrum pre- and post-emergent herbicide for both broadleaf species and grasses.	Used at low rates as a pre-emergent along roadsides. Known to be effective on canary reedgrass (but not labeled for aquatic use), cheatgrass and medusahead.	Without drift mitigation (selective spot hand treatment, etc.), offsite drift from ground broadcast application may cause damage to non-tolerant plants up to 900'. Highly mobile by water or by wind erosion. Substantial damage has occurred to croplands in arid and wet regions. Damage to some aquatic plants possible at peak concentration
Triclopyr / (Garlon, Pathfinder, Remedy) / *Synthetic auxin - Mimics natural plant hormones.*	A growth regulating selective, systemic herbicide for control of woody and broadleaf perennial weeds.	Not for broadcast application under proposed action. Little or no impact on grasses. Effective for many woody species such as basal bark or cut stump treatment for salt cedar.	Garlon 4 (ester compound) is toxic to fish and aquatic invertebrates. Amine formulations may be used near or over water. Offsite movement by water possible. Without drift mitigation (selective spot hand treatment, etc.), off site drift from ground broadcast application may damage non-tolerant plants up to 100 feet.

FORMULATIONS

A herbicide formulation is the total marketed product, and is typically available in forms that can be sprayed on as liquids or applied as dry solids. It includes the active ingredient(s), any additives that enhance herbicide effectiveness, stability, or ease of application such as surfactants and other adjuvants, and any other ingredients including solvents, carriers, or dyes. The application method and species to be treated will determine which formulation is best to use. In most cases, manufacturers produce formulations that make applications and handling simpler and safer. Some herbicides are available in forms that can reduce risk of exposure during mixing, such as pre-measured packets that dissolve in water, or as a liquid form already mixed with surfactant and dye (e.g., triclopyr - Pathfinder II®).

Sprayable / Liquid Formulations

Water-soluble formulations: soluble liquids , soluble powders or packets, and soluble granules. Only a few herbicidal active ingredients readily dissolve in water. These products will not settle out or separate when mixed with water.

Emulsifiable formulations (oily liquids): emulsifiable concentrates and gels. These products tend to be easy to handle and store, require little agitation, and will not settle out of solution. Disadvantages of these products are that most can be easily absorbed through the skin and the solvents they contain can cause the rubber and plastic parts of application equipment to deteriorate.

Liquid suspensions (liquid or flowable) that are dispersed in water include: suspension concentrates, aqueous suspensions, emulsions of water-dissolved herbicide in oil, emulsions of an oil-dissolved herbicide in water, micro-encapsulated formulations, and capsule suspensions. All these products consist of a particulate or liquid droplet active ingredient suspended in a liquid. They are easy to handle and apply, and rarely clog nozzles. However, they can require agitation to keep the active ingredients from separating out.

Dry solids that are suspended in water include: wettable powders, water-dispersible granules, or dry flowables. These formulations are some of the most widely used. The active ingredient is mixed with a fine particulate carrier, such as clay, to maintain suspension in water. These products tend to be inexpensive, easy to store, and are not as readily absorbed through the skin and eyes as emulsifiable concentrates or other liquid formulations. These products, however, can be inhalation hazards during pouring and mixing. In addition, they require constant agitation to maintain suspension and they may be abrasive to application pumps and nozzles.

Dry Formulations

Granules: Granules consist of the active ingredient absorbed onto coarse particles of clay or other substance, and are most often used in soil applications. These formulations can persist for some time and may need to be incorporated into the soil.

Pellets or tablets: Pellets are similar to granules but tend to be more uniform in size and shape.

Dusts: A dust is a finely ground pesticide combined with an inert or inactive dry carrier. They can pose a drift or inhalation hazard.

Salts versus Esters

Many herbicidally active compounds are acids that can be formulated as a salt or an ester for application. Once the compound enters the plant, the salt or ester cation is cleaved off. This allows the parent acid (active ingredient) to be transported throughout the plant. When choosing between the salt or ester formulation, consider the following characteristics:

Salts: Most salts are highly water soluble, which reduces the need for emulsifiers or agitation to keep the compound suspended. Salts are not soluble in oil. They generally require a surfactant to facilitate penetration through the plant cuticle (waxy covering of leaves and stems). Salts are less volatile than esters and can dissociate in water. In hard water the parent acid (i.e. the active ingredient) may bind with calcium and magnesium in the water, precipitate out, and be inactivated.

Esters: Esters can penetrate plant tissues more readily than salts, especially woody tissue. Esters generally are more toxic to plants than salts. They are not water soluble and require an emulsifying agent to remain suspended in water-based solvents. Esters have varying degrees of volatility

Adjuvants / Surfactants

An adjuvant is any material added to a pesticide mixture that facilitates mixing, application or pesticide efficacy. An adjuvant enables an applicator to customize a formulation to be most effective in a particular situation. Adjuvants include surfactants, stickers, extenders, activators, compatibility agents, fertilizers, buffers and acidifiers, deposition aids, de-foaming agents, thickeners, and dyes. See Appendix J for more details on adjuvants. Some fertilizers, alone, may be effective for tall larkspur control, such as ammonium sulfate.

Surfactants are the most important adjuvants. They are chemical compounds that facilitate the movement of the active herbicide ingredient into the plant. They may contain varying amounts of fatty acids that are capable of binding to two types of surfaces, such as oil and water. Some herbicide formulations come with a surfactant already added, in others, surfactants can be added prior to application. Whether a surfactant should be added will be determined by the type of herbicide being applied and the target plant. The label should be followed for use of appropriate surfactants.

Adjuvants are not under the same registration guidelines as are pesticides. The U.S. Environmental Protection Agency (U.S. EPA) does not register or approve the labeling of spray adjuvants. All adjuvants are generally field tested by the manufacturer with several different herbicides against many weeds, and under different environments. Basic information concerning adjuvants commonly used with herbicides describes hazard information and is used in conjunction with Forest Service national herbicide risk assessments (Bakke 2002).

MECHANISMS OF DISSIPATION

Dissipation refers to the movement, degradation, or immobilization of an herbicide in the environment.

Degradation: Degradation occurs when an herbicide is decomposed to smaller component compounds, and eventually to CO_2, water, and salts, through photochemical, chemical, or biological (microbial metabolism) reactions. Biodegradation accounts for the greatest percentage of degradation for most herbicides (Tu, et. al., 2001). When a single herbicide degrades, it usually yields several compounds ("metabolites"), each of which has its own chemical properties including toxicity, adsorption capacity, and resistance to degradation. Some metabolites are more toxic and/or persistent than the parent compound. In most cases, the natures of the metabolites are largely unknown.

Photodegradation: Photodegradation refers to decomposition by sunlight. Sunlight intensity varies with numerous factors including latitude, season, time of day, weather, pollution, and shading by soil, plants, litter, etc. Studies of the photodegradation of herbicides are often conducted using UV light exclusively, but there is some debate as to whether most UV light actually reaches the surface of the earth. Therefore, photodegradation rates determined in the laboratory may over-estimate the importance of this process in the field (Tu, et. al., 2001).

Microbial Degradation: Microbial degradation is decomposition through microbial metabolism. Different microbes can degrade different herbicides, and consequently, the rate of microbial degradation depends on the microbial community present in a given situation (Voos and Groffman 1997). Soil conditions that maximize microbial degradation include warmth, moisture, and high organic content.

Herbicides may be microbially degraded via one of two routes. They may be metabolized directly when they serve as a source of carbon and energy (i.e. food) for microorganisms, or they may be co-metabolized in conjunction with a naturally occurring food source that supports the microbes (Tu, et. al., 2001). Herbicides that are co-metabolized do not provide enough energy and/or carbon to support the full rate of microbial metabolism on their own.

There is sometimes a lag time before microbial degradation proceeds. This may be because the populations of appropriate microbes or their supplies of necessary enzymes start small, and take time to build up. If this lag time is long, other degradation processes may play more important roles in dissipation of the herbicide (Tu, et. al., 2001). Degradation rates of co-metabolized herbicides tend to remain constant over time.

Chemical Decomposition: Chemical decomposition is degradation driven by chemical reactions, including hydrolyzation (reaction with hydrogen, usually in the form of water), oxidation (reaction with oxygen), and disassociation (loss of an ammonium or other chemical group from the parent molecule). The importance of these chemical reactions for herbicide degradation in the field is not clear (Tu, et. al., 2001).

Immobilization/Adsorption: Herbicides may be immobilized by adsorption to soil particles or uptake by non-susceptible plants. These processes isolate the herbicide and prevent it from moving in the environment, but both adsorption and uptake are reversible. In addition, adsorption can slow or prevent degradation mechanisms that permanently degrade the herbicide.

Adsorption refers to the binding of herbicide by soil particles, and rates are influenced by characteristics of the soil and of the herbicide. Adsorption is often dependent on the soil or water pH, which then determines the chemical structure of the herbicide in the environment. Adsorption generally increases with increasing soil organic content, clay content, and cation exchange capacity, and it decreases with

increasing pH and temperature. Soil organic content is thought to be the best determinant of herbicide adsorption rates (Tu, et. al., 2001). Adsorption is also related to the water solubility of an herbicide, with less soluble herbicides being more strongly adsorbed to soil particles. Solubility of herbicides in water generally decreases from salt to acid to ester formulations, but there are some exceptions. For example, glyphosate is highly water-soluble and has a strong adsorption capacity.

The availability of an herbicide for transport through the environment or for degradation is determined primarily by the adsorption/desorption process. Adsorption to soil particles can stop or slow the rate of microbial metabolism significantly. In other cases, adsorption can facilitate chemical or biological degradation (Tu, et. al., 2001). Adsorption can change with time and, in most cases, is reversible (i.e. the herbicide can desorb from the soil or sediments and return to the soil solution or water column).

Movement/Volatilization: Movement through the environment occurs when herbicides are suspended in surface or subsurface runoff, volatilized during or after application, evaporated from soil and plant surfaces, or leached down into the soil. Although generally studied and discussed separately, these processes actually occur simultaneously and continuously in the environment (Tu, et. al., 2001).

Volatilization occurs as the herbicide passes into the gaseous phase and moves about on the breeze. Volatilization most often occurs during application, but also can occur after the herbicide has been deposited on plants or the soil surface. The volatility of an herbicide is determined primarily by its molecular weight. Most highly volatile herbicides are no longer used.

Volatility generally increases with increasing temperature and soil moisture, and with decreasing clay and organic matter content (Tu, et. al., 2001). The use of a surfactant can change the volatility of a herbicide. In extreme cases, losses due to volatilization can be up to 80 or 90% of the total herbicide applied (Tu, et. al., 2001). Of the herbicides in this analysis, only 2, 4-D and triclopyr can present volatilization problems in the field.

HERBICIDE RESISTANCE

Herbicide resistance is the genetic ability of an individual plant to survive a herbicide application to which the wild-type population is otherwise susceptible. Resistant individuals remain reproductively compatible with the wild-type, and may confer genetic resistance to their offspring.

Resistance may occur in plants by random and infrequent mutations. Through selection, where the herbicide is the selection pressure, susceptible plants are killed while herbicide resistant plants survive to reproduce without competition from susceptible plants. If the herbicide is continually used, resistant plants successfully reproduce and become dominant in the population.

Herbicide resistance was first reported in 1957 in California with common groundsel (*Senecio vulgaris*) (Prather et al., 2000). Development of resistance occurs mostly in croplands where repeated applications of a single herbicide select for resistant survivors. However, resistance is known to occur in a few wildland invasives, including yellow starthistle resistance to picloram and clopyralid (Sabba et al., 2003). A resistant biotype was observed in Washington in a pasture subjected to intensive picloram selective pressure. Reports of resistant strains of perennial ryegrass (*Lolium perenne*) to sulfometuron methyl, Russian thistle (Salsola tragus) to chlorosulfuron and sulfometuron have been found in California (Prather et al, 2000). Other resistant species were reported.

Resistance to glyphosate is debated in the literature (Owen and Zelaya, 2005). Arguments indicate that not only would the evolution of glyphosate resistance be an issue, but also weed populations shifts would occur in response to the adoption of glyphosate-resistant crops. In field situations, resistance to sulfonylurea herbicides has been reported to occur after 3 to 5 years of repeated use (Liebman, et. al., 2001).

Herbicide factors that contribute to the potential for resistance include long soil residual activity, single target site and specific mode of action, and high effective kill of a wide range of weed species. All of these factors rapidly deplete susceptible genes from the population (Prather et al., 2000). Resistance is avoided or overcome by having multiple herbicides with different modes of action (plant-killing chemistries)

available for use. The use of short-residual herbicides also reduces selection pressure for herbicide resistance as well as integrating non-herbicide control techniques into a weed management program (Prather et al., 2000).

The repeated use of one herbicide allows these few resistant plants to survive and reproduce. As the number of resistant plants increases, the efficacy of the herbicide diminishes until the herbicide no longer effectively controls the undesirable plant populations. Where repeated herbicide use is predicted to be necessary to meet control objectives, strategies must be designed to minimize risk of developing resistance.

To develop resistance avoidance strategies, long-term site plans should recognize which of the various herbicide families have available and effective herbicides if multiple applications are expected to be necessary. Integrated chemical and non-chemical controls are highly effective where feasible because any surviving herbicide resistant plants can be removed from the site.

The threat of the weeds occurring on the Custer National Forest developing a resistance to the herbicides has not been documented to date. However, the likelihood of this happening does exist. As an adaptive management approach, herbicide rotation will be considered where resource management objectives can still be met. Rotating herbicides by chemical family and preferably by mode of action would minimize the potential development of herbicide resistant weeds. See Appendix E.

BEHAVIOR IN THE ENVIRONMENT

Perhaps the most important factor determining the fate of herbicide in the environment is its solubility in water (Tu, et. al., 2001). Water-soluble herbicides generally have low adsorption capacities, and are consequently more mobile in the environment and more available for microbial metabolism and other degradation processes. Esters, in general, are relatively insoluble in water, adsorb quickly to soils, penetrate plant tissues readily, and are more volatile than salt and acid formulations (Tu, et. al., 2001).

The toxicology information indicated is for the technical grade of the herbicide unless otherwise noted. In some cases, it is not the herbicide itself that is the most toxic component of the applied formula. Adjuvants, such as petroleum solvents (e.g. diesel fuel, deodorized kerosene, methanol), can be highly toxic (Tu, et. al., 2001). In addition, impurities resulting from the manufacturing process can be more toxic than the active ingredient itself.

Soils

An herbicide's persistence in soils is often described by its half-life (also known as the DT50). The half-life is the time it takes for half of the herbicide applied to the soil to dissipate. The half-life gives only a rough estimate of the persistence of an herbicide since the half-life of a particular herbicide can vary significantly depending on soil characteristics, weather (especially temperature and soil moisture), and the vegetation at the site. Dissipation rates often change with time (Voos and Groffman, 1997). Nonetheless, half-life values do provide a means of comparing the relative persistence of herbicides.

The distribution of an herbicide in the soil is determined primarily by the amount, type, and surface area of clays and organic matter in the soil, the amount and quality of soil moisture, and soil temperature and soil pH (Tu, et. al., 2001). Most natural soils have pH values between 5 and 8. Rainfall and the amount of leaching that has occurred strongly influence these values. In wet areas and/or coarse soils, cations can be leached out, leaving the soil acidic. In arid and semi-arid regions, soils retain cations and are more alkaline. Acidic soils can also be found in bogs where organic acids lower the soil's pH.

See the Soils and Groundwater section of this chapter for more detailed information.

Water

Water bodies can be contaminated by direct overspray, or when herbicides drift, volatilize, leach through soils to groundwater, or are carried in surface or subsurface runoff. Amounts of leaching and runoff are largely dependent on total rainfall the first few days after an application. Total losses to runoff generally do not exceed five to ten percent of the total applied, even following heavy rains (Tu, et. al., 2001). High soil adsorption capacity, low rates of application and low rainfall reduce total runoff and contamination of local waterways (Bovey et al. 1978).

The behavior of an herbicide in water is dictated by its solubility in water. Salts and acids tend to remain dissolved in water until degraded through photolysis or hydrolysis. Esters will often adsorb to the suspended matter in water, and precipitate to the sediments. Once in the sediments, esters can remain adsorbed to soil particles or be degraded through microbial metabolism. Highly acidic or alkaline waters can chemically alter an herbicide and change its behavior in water. The average pH of surface waters is between five and nine (Tu, et. al., 2001).

See the Water Quality, Fisheries, and Amphibians section of this chapter for more detailed information.

Birds and Mammals

A herbicide's toxicity is described by its LD50, which is the dose received either orally (taken through the mouth) or dermally (absorbed through the skin) that kills half the population of study animals. The oral LD50s reported here were determined for adult male rats. The dermal LD50s were determined for rabbits. The LD50 is typically reported in grams of herbicide per kilogram of animal body weight. LD50s are determined under varying circumstances so comparisons between different herbicides may provide only a rough sense of their relative toxicities. Dermal LD50 values may be more meaningful to herbicide applicators because they are more likely to be exposed to herbicide through their skin rather than by oral ingestion. In any event, very few people, even among applicators, are exposed to herbicide doses as high as the LD50.

The LD50 does not provide any information about chronic, long-term toxic effects that may result from exposure to lesser doses. Sublethal doses can lead to skin or eye irritation, headache, nausea, and, in more extreme cases, birth defects, genetic disorders, paralysis, cancer, and even death. Impurities derived from the formulation of the herbicide and the adjuvants added to the formulation may be more toxic than the herbicide compound itself, making it difficult to attribute increased risks of cancer or other effects directly to a herbicide (Ibrahim et al. 1991).

The most dramatic effects of herbicides on non-target plants and animals often result from the habitat alterations they cause by killing the targeted weeds. For example, loss of invasive riparian plants can cause changes in water temperature and clarity that can potentially impact the entire aquatic community, and the physical structure of the system through bank erosion. Removing a shrubby understory can make a habitat unsuitable for certain bird species and expose small mammals to predation.

See the Wildlife section of this chapter for more detailed information.

Aquatic Species

A herbicide's toxicity to aquatic organisms is quantified with the LC50, which is the concentration of herbicide in water required to kill half of the study animals. The LC50 is typically measured in micrograms of pesticide per liter of water.

In general, ester formulations are more dangerous for aquatic species than salt and acid formulations because ester formulations are lipophilic (fat-loving), and consequently, can pass through the skin and gills of aquatic species relatively easily. Ester formulations, additionally, are not water soluble, and are less likely to be diluted in aquatic systems.

See the Water Quality, Fisheries, and Amphibians section of this chapter for more detailed information.

Soil Microbes

Herbicides have varying effects on soil microbial populations depending on herbicide concentrations and the microbial species present. Low residue levels can enhance populations while higher levels can cause population declines. In many cases, studies are too short in duration to determine the true long-term impacts of herbicide use on soil microbes.

HUMAN TOXICOLOGY

When proper safety precautions are taken, human exposure to herbicides used in natural areas should be minimal. Properly fitted personal protective equipment and well-planned emergency response procedures will minimize exposure from normal use as well as emergency spill situations (see Appendix M). See the Human Health section of this chapter for more detailed information.

Exposure

Agricultural workers are often exposed to herbicides when they unintentionally re-enter a treated area too soon following treatment. People who mix and apply herbicides are at the greatest risk of exposure. The most common routes of exposure are through the skin (dermal) or by inhalation (to the lungs). Accidental spills or splashing into the eyes is also possible and with some compounds, can result in severe eye damage and even blindness.

Agricultural herbicide applicators are typically exposed to herbicide levels ranging from micrograms to milligrams per cubic meter of air through inhalation, but exposures through the skin are thought to be much greater (Tu, et. al., 2001). Spilling concentrated herbicide on exposed skin can be the toxic equivalent of working all day in a treated field (Tu, et. al., 2001). Dermal exposure can occur to the hands (directly or through permeable gloves), splashes onto clothing or exposed skin, and anywhere you wipe your hands (e.g., thighs, brow). Some tests have found relatively high levels of dermal exposure to the crotch and seat of workers who got herbicide on their hands, and then touched or wiped the seat of their vehicles. Because adsorption through the skin is the most common route of exposure for applicators (Tu, et. al., 2001), the dermal LD50 may provide more practical information on the relative toxicity of an herbicide rather than the oral LD50, which is based on oral ingestion.

Toxic Effects

A person's reaction to pesticide poisoning depends on the toxicity of the pesticide, the size of the dose, duration of exposure, route of absorption, and the efficiency with which the poison is metabolized and excreted by the person's body (Tu, et. al., 2001). Different individuals can have different reactions to the same dose of herbicide. Smaller people are, in general, more sensitive to a given dose than are larger people.

Herbicides can poison the body by blocking biochemical processes or dissolving or disrupting cell membranes. Small doses may produce no response while large doses can cause severe illness or death. The effects may be localized, such as irritation to the eyes, nose, or throat, or generalized, such as occurs when the compound is distributed through the body via the blood stream. Symptoms can occur immediately after exposure or develop gradually. Injuries are usually reversible, but in extreme cases can be permanently debilitating (Tu, et. al., 2001).

Common symptoms of low-level exposure (such as occurs when mixing or applying herbicides in water) to many herbicides include skin and eye irritation, headache, and nausea. Higher doses (which can occur when handling herbicide concentrates) can cause blurred vision, dizziness, heavy sweating, weakness, stomach pain, vomiting, diarrhea, extreme thirst, and blistered skin, as well as behavioral alterations such as apprehension, restlessness, and anxiety (Tu, et. al., 2001). Extreme cases may result in convulsions, unconsciousness, paralysis, and death.

Impurities produced during the manufacturing process and adjuvants added to the formulation may be more toxic than the herbicide compound itself. Consequently, LD50s determined for the technical grade of

the herbicide may not be the same as that for the brand name formulation. Combinations of herbicides furthermore, can have additive and synergistic effects in which a formulation of two or more herbicides is two to 100 times as toxic as any one of the herbicides alone (Thompson 1996). Labels for manufacturer's warnings and safety precautions that may be required for a particular formulation should be read carefully.

HUMAN HEALTH

The control of weeds by chemical, than by other means, is often of concern to the public from the standpoint of possible effects on human health.

Human Health - Regulatory Framework

Safety standards for herbicide use are set by the Environmental Protection Agency (EPA), Occupational Health and Safety Administration, Code of Federal Regulations (40 CFR part 170), and individual states. In addition, several sections of the Forest Service Manual (FSM, 1994) provide guidance to the safe handling and application of herbicides. These include:

- Consultation of pesticide handling requirements set forth in the Forest Service Health and Safety Code Handbook (FSM 6709.11) and (FSM 2156) (see Appendix M);
- Pesticide-Use Management and Coordination Handbook that requires the Forest Service to review pesticide use proposals in terms of human health (FSM 2109.13.2);
- Recommendation to complete environmental and human health risk assessments prior to pesticide use to ensure public safety (FSM 2109.14);
- Completion of project work plans prior to implementation, including a description of personal protective clothing and equipment required (FSM 2109.14.3);
- Development of a safety plan to protect the public and employees from unsafe work conditions when pesticides are involved (FSM 2109.16, FSM 2153.3);
- Safety and Health Hazard Analysis that requires completion of a Job Hazard Analysis (Form FS-6700-7) to determine hazards on the project and identify ways to eliminate them (FSM 2109.16.2, FSM 6700, FSH 6709.11) (see Appendix M).

Finally, FSM 2109.16.3 states the requirement for, and defines Pesticide Risk Assessment as another method of helping to ensure environmental health and human safety in pesticide use. Risk analysis is used to quantitatively evaluate the probability that a given pesticide use might impose harm on humans or other species in the environment. It is the same process used for regulation of food activities, medicine, cosmetics and other chemicals.

These analyses are usually incorporated into the decision making documents prepared in compliance with the National Environmental Policy Act (FSM 1950). A pesticide risk assessment does not, in itself, ensure safety in pesticide use. The analysis is tied to protection measures (see Appendix C) and label requirements to avoid potential risks identified by the risk assessment.

Human Health - Methodology for Analysis

As herbicides have the potential to adversely affect the environment or human health, the U.S. Environmental Protection Agency (EPA) must register all herbicides prior to their sale, distribution, or use in the United States. In order to register herbicides for outdoor use, the EPA requires the manufacturers to conduct a lab evaluation of potential hazards to humans and on wildlife including toxicity testing on representative species of birds, mammals, freshwater fish, aquatic invertebrates, and terrestrial and aquatic plants. An ecological risk assessment uses the data collected to evaluate the likelihood that adverse ecological effects may occur as a result of herbicide use.

The effects from the use of any herbicide depends on the toxic properties (hazards) of that herbicide, the level of exposure to that herbicide at any given time, and the duration of that exposure. The risk from herbicide use can be reduced by reducing exposure through site-specific project design criteria, such as the use of streamside buffer zones, personal protective equipment for applicators, and posting of treated areas. Protection measures specified in Chapter 2, and Appendices, C, G, and J along with scientific

literature on toxicity and risks will help assess effects of possible exposure, pesticide toxicity, and pesticide doses workers and the public may receive, and are compared to levels of no observed effects.

Treatments under all alternatives would be accomplished according to strict safety and health standards.

To assess concerns related to herbicide use, the USDA Forest Service (Forest Service) contracted Syracuse Environmental Research Associates, Inc. (SERA), to complete risk assessments for herbicides the Forest Service uses to control noxious weeds and other invasive species. These assessments and EPA risk assessments evaluate potential risks to human health and the environment. The SERA assessments use peer-reviewed articles from the open scientific literature and current EPA documents, including Confidential Business Information.

Human Health Risk Assessments

The methodologies used to assess human health risks meet Forest Service direction for completion of a risk assessment per Forest Service Handbook 2109.14, Chapter 10. Human health risks are based on information found in various herbicide risks assessments conducted by the Forest Service (SERA, 1999-2004) (http://www.fs.fed.us/foresthealth/pesticide/risk.shtml), the Bureau of Land Management (http://www.blm.gov/nhp/spotlight/VegEIS/hhra.htm), and the Environmental Protection Agency (EPA) (http://www.epa.gov/iris/index.html) and EPA re-registration decisions (http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg) for each EPA approved herbicide considered, and are incorporated into this analysis by reference. These assessments are incorporated into this analysis by reference. Toxicity and exposure information for herbicides was reviewed to determine the levels of these chemicals that would be harmful to human health. Potential exposures and doses are estimated for workers and the general public. Toxic effect levels are compared to predicted dose levels to determine the possibility of human impact.

EPA regulates pesticides under two major federal statutes. Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), EPA registers pesticides for use in the United States and prescribes labeling and other regulatory requirements to prevent unreasonable adverse effects on health or the environment. Under the Federal Food, Drug, and Cosmetic Act (FFDCA), EPA establishes tolerances (maximum legally permissible levels) for pesticide residues in food. The 1996 Food Quality Protection Act (FQPA) amended both major pesticide laws to establish a more consistent, protective regulatory scheme, grounded in sound science. It mandates a single, health-based standard for all pesticides in all foods; provides special protections for infants and children; expedites approval of safer pesticides; creates incentives for the development and maintenance of effective crop protection tools for American farmers; and requires periodic re-evaluation of pesticide registrations and tolerances to ensure that the scientific data supporting pesticide registrations will remain up to date in the future. EPA evaluates the available toxicity data and considers its validity, completeness, and reliability as well as the relationship of the results of the studies to human risk.

The FQPA requirements included a new safety standard for reasonable certainty of no harm that must be applied to all pesticides used on foods. The dose at which no adverse effects are observed (the NOAEL) from the toxicology study identified as appropriate for use in risk assessment is used to estimate the toxicological level of concern (LOC). However, the lowest dose at which adverse effects of concern are identified (the LOAEL) is sometimes used for risk assessment if no NOAEL was achieved in the toxicology study selected. An uncertainty factor (UF) is applied to reflect uncertainties inherent in the extrapolation from laboratory animal data to humans and in the variations in sensitivity among members of the human population as well as other unknowns. An UF of 100 is routinely used, 10X to account for interspecies differences and 10X for intraspecies differences.

Three other types of safety or UFs may be used: "Traditional uncertainty factors;" the "special Food Quality Protection Act of 1996 (FQPA) safety factor;" and the "default FQPA safety factor." By the term "traditional uncertainty factor," EPA is referring to those additional UFs used prior to FQPA passage to account for database deficiencies. These traditional uncertainty factors have been incorporated by the FQPA into the additional safety factor for the protection of infants and children. The term "special FQPA safety factor" refers to those safety factors that are deemed necessary for the protection of infants and children primarily as a result of the FQPA. The "default FQPA safety factor" is the additional 10X safety

factor that is mandated by the statute unless it is decided that there are reliable data to choose a different additional factor (potentially a traditional uncertainty factor or a special FQPA safety factor).

For dietary risk assessment (other than cancer) the EPA uses the UF to calculate an acute or chronic reference dose (acute RfD or chronic RfD) where the RfD is equal to the NOAEL divided by an UF of 100 to account for interspecies and intraspecies differences and any traditional uncertainty factors deemed appropriate (RfD = NOAEL/UF). Where a special FQPA safety factor or the default FQPA safety factor is used, this additional factor is applied to the RfD by dividing the RfD by such additional factor. The acute or chronic population adjusted dose (aPAD or cPAD) is a modification of the RfD to accommodate this type of safety factor.

For non-dietary risk assessments (other than cancer) the UF is used to determine the LOC. For example, when 100 is the appropriate UF (10X to account for interspecies differences and 10X for intraspecies differences) the LOC is 100. To estimate risk, a ratio of the NOAEL to exposures (margin of exposure (MOE) = NOAEL/exposure) is calculated and compared to the LOC.

The linear default risk methodology (Q*) is the primary method currently used by the EPA to quantify carcinogenic risk. The Q* approach assumes that any amount of exposure will lead to some degree of cancer risk. A Q* is calculated and used to estimate risk which represents a probability of occurrence of additional cancer cases (e.g., risk). An example of how such a probability risk is expressed would be to describe the risk as one in one hundred thousand (1 X 10-\5\), one in a million (1 X 10-\6\), or one in ten million (1 X 10-\7\).

Under certain specific circumstances, MOE calculations will be used for the carcinogenic risk assessment. In this non-linear approach, a “point of departure" is identified below which carcinogenic effects are not expected. The point of departure is typically a NOAEL based on an endpoint related to cancer effects though it may be a different value derived from the dose response curve. To estimate risk, a ratio of the point of departure to exposure (MOE_{cancer} = point of departure/exposures) is calculated.

Specific methods used in preparing the Forest Service (FS) / SERA herbicide risk assessments are described in SERA, 2001-Preparation (project file) and incorporate EPA methods. To evaluate potential risks to human health and the environment, FS/SERA (2003-2004) risk assessments use peer-reviewed articles from the open scientific literature and current EPA documents, including Confidential Business Information. Only specific information that is not derived from the relevant SERA Risk Assessments is specifically cited. The risk assessments and associated documentation is available in total in the project record for this EIS.

Toxicity studies were evaluated individually for scientific quality, and cumulatively for all similar studies to identify the No observed adverse effects level (NOAEL) and Reference Dose (RfD) for the most sensitive adverse effect on the test organism. Each EPA and Forest Service/SERA Risk Assessment contains citations for all studies that are reviewed.

The analysis of the potential human health effects associated with the use of herbicides uses the methodology of risk assessment generally accepted by the scientific community (National Research Council, 1983; EPA, 1987 in SERA, 2001-Preparation). Forest Service/SERA Risk Assessments estimate doses to workers from herbicide application, and doses to the public from being on or near an application site. Estimated worker doses and public doses are compared to Reference Doses (RfD). A RfD is a dose of herbicide determined to be safe by the EPA over a lifetime of daily exposure. RfDs are based upon doses shown to cause no observed ill effects to test animals in either short-term (acute) or long-term (subchronic or chronic) studies. Human exposure doses are reduced from those found protection of test animals, based on possible variation between species and among individual people. Different types of possible effects are considered, including acute and chronic systemic effects, cancer, teratogenic (birth defects), mutagenic (gene mutation), and reproductive effects.

The risk assessments use the threshold levels for acceptable risk established by EPA: the RfD is the threshold level for exposure for non-carcinogenic health effects, and one-chance-in-one million is the cancer risk threshold level. A Hazard Quotient (HQ) has been computed for the exposures estimated for

workers and members of the public by dividing the dose predicted from a noxious weed treatment by the RfD. In general, if the HQ is less than or equal to 1, the risk of effects is considered negligible.

One of the primary uses of a risk assessment is for risk management. Decision-makers can use the EIS human health risk assessment to identify those herbicides, application methods, or exposure rates that pose the greatest risks to workers and the public. Specific protection measures can then be employed where the decision-maker feels the risks are unacceptably high. Reducing exposure can reduce risk. The use of streamside buffer zones, personal protective equipment for applicators, and posting of treated areas are all examples of ways to reduce exposure to workers and the public. Decision-makers determine when to implement protection measures on specific treatment projects for herbicides available for use in the Record of Decision for the EIS.

Because any risk assessment is based on a number of assumptions, readers and decision-makers should not conclude that the risk values are absolute. If the assumptions are changed, the risk values change. However, the relative risk among herbicides or methods should remain the same unless new toxicity data becomes available.

Health risks from herbicide use depend on the toxic properties of that herbicide, the level of exposure to that herbicide, and the duration of exposure. Chapter 4 discloses the potential for adverse health effects to workers and members of the public, from treatment of noxious weeds using the herbicides as proposed in the EIS alternatives.

In addition to the analysis of potential hazards to human health from every herbicide active ingredient, EPA and Forest Service/SERA Risk Assessments evaluate any available scientific studies of potential hazards of these other substances associated with herbicide applications: impurities, metabolites, inert ingredients, and adjuvants. There is usually less information available on these substances (compared to the herbicide active ingredient) because they are not subject to the extensive testing that is required for herbicide active ingredients under FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act).

Other chemical effects associated with the application of herbicides (Impurities, Metabolites, and Inert Ingredients) are discussed in Chapter 4. Potential human risk and environmental effects are also analyzed in relevant sections of Chapter 4.

Limitations of Risk Assessments

The analysis in Chapter 4 refers extensively to Forest Service risk assessments (prepared by SERA, Inc.) and to some degree the EPA risk assessments for every herbicide considered in the alternatives. Risk assessments use information from laboratory and field studies of herbicide toxicity, exposure, and environmental fate to estimate the risk of adverse effects to non-target organisms. Risk assessments are often used to inform decision makers, notwithstanding the presence of some degree of uncertainty inherent in any methodology used to assess risk. When used in conjunction with information on local conditions and specific treatments, risk assessments become a more precise tool. There are advantages and disadvantages to the risk assessment process as it relates to natural resources.

Advantages of risk assessment include: providing quantitative bases for comparing and prioritizing risks of alternatives; providing to decision makers and the public an estimate of the risk of the occurrence of an adverse effect under typical and extreme scenarios.

Disadvantages include a high degree of uncertainty in interpretation and extrapolation of data. Uncertainty may result from a study design, questions asked (and questions avoided), data collection, data interpretation, and extreme variability associated with aggregate effects of natural and synthesized chemicals on organisms, including humans, and with ecological relationships. Numbers used, particularly in ecological realms, are uncertain, and there are limits on our ability to understand or demonstrate causal relationships. Because of data gaps, assessments rely heavily on extrapolation from laboratory animal tests (Power and Adams, 1997).

Regardless of disadvantages and limitations of ecological and human health risk assessments, the analysis provided by Forest Service/SERA Risk Assessments is the most current and thorough that is

available. Risk assessments can determine (given a particular set of assumptions) whether there is a basis for asserting that a particular adverse effect is plausible. The bottom line for all risk analyses is that absolute safety can never be proven and the absence of risk can never be guaranteed (SERA, 2001).

Human Health - Affected Environment

Weed management has potential to affect human health. Concerns are related to the exposure to toxicants found in the herbicides used in ground and aerial applications. Mechanical methods of control may expose workers to plant chemicals, which can cause a reaction in some workers. To date biological, seeding, and grazing control methods have not been shown to be of concern from a human health standpoint. An integrated weed program must be implemented in such a manner as to minimize risk to workers and the general public.

The general public use of the Custer National Forest is primarily recreational in nature. However, other human uses include commodity-oriented such as logging, grazing and mineral extraction, and traditional cultural uses such as plant gathering and use.

The Forest provides a wide range of recreation experiences. At one end of the spectrum are primitive non-motorized opportunities in places like the Cook Mountain Riding and Hiking Area, and the Absaroka-Beartooth Wilderness Area. The other end of the spectrum includes more developed settings like Red Lodge Mountain Ski Area. Weeds can be found in most any of the recreation settings on the Forest. Weeds are frequently spread through recreational activities, particularly along roads, trails, campgrounds, and dispersed recreation sites. See the Recreation section of Chapters 3 and 4 for more detailed information.

Other human uses include domestic water. West Fork Rock Creek (Beartooth Ranger District) is a municipal watershed for the city of Red Lodge and classified as A-1 waters. A-1 classification standards are the most stringent and specific to maintaining water quality for domestic uses. The City of Red Lodge, however, is currently using an alternate source of water and may use the West Fork Rock Creek intake as a backup source. See the Water Quality section of Chapters 3 and 4 for more detailed information. Summer homes, adjacent private land uses in East Rosebud, West Rosebud, and Stillwater drainages may have developed water sources for culinary uses. Label instruction and protection measures outlined in Appendix C will be followed near potable water sources.

Generally, less than 20 workers load, mix, and apply herbicides annually on the Custer National Forest either through government employees, contractors, or agreements with counties.

SOILS AND GROUND WATER

Soils and Ground Water - Regulatory Framework

The National Forest Management Act requires that lands be managed to ensure the maintenance of long-term soil productivity, soil hydrologic function, and ecosystem health. Soil resource management will be consistent with these goals.

The Forest Service Manual (FSM) 2550 – Soil management has a goal to optimize sustained yield of goods and services without impairing the productivity of the land, and it is the policy of the Forest Service to manage land in a manner that will improve soil productivity.

Other laws and guidance include the Soil Conservation and Domestic Allotment Act (16 USC 590) that states soil erosion is a menace to national welfare. This Act provides for the prevention of erosion on lands owned or controlled by the United States through a variety of means including the establishment of vegetative cover. In addition, Congress declares that unsatisfactory conditions on public lands present a high risk of soil loss, subsequent loss of productivity, and unacceptable levels of siltation that can be mediated by increasing rangeland management (43. CFR §1901).

Soils and Ground Water - Affected Area

Affected areas for the impact analysis of proposed actions on soil quality are weed-infested sites currently under consideration for spray with herbicides. Noxious weeds currently infest approximately 1,500 net acres on the Custer National Forest. (see Chapter 2 and project file).

Noxious weeds occur on most combinations of landforms, geology, and soil in the plains to mid-montane elevation zones. Soils are usually highly variable in degree of development, texture, organic matter and coarse fragments (Published County Soil Surveys of Harding County, SD, Carter County, MT, Powder River Area, MT, and Carbon County, MT and the Beartooth Terrestrial Ecological Unit Inventory (TEUI), in progress, available at the Supervisor's Office, Billings, MT).

Soils and Ground Water - Analysis Method

Impacts on soil quality resulting from weed infestation and weed control measures were incorporated by reference from other recent weed EIS (as discussed below). To assess impacts to ground water quality, the RAVE (Relative Aquifer Vulnerability Evaluation) model was used (developed by Montana State University Extension Service, 1990). Geographic Information System (GIS) incorporated the RAVE model, herbicide soil mobility rate, the soil survey and draft Terrestrial Ecological Unit Inventory information, distance to water, and topographic position. The GIS analysis allowed for a landscape analysis so that areas with low to unacceptable risk of groundwater contamination could be identified. See Chapter 4 for more details of this analysis process and the map section for landscape level maps.

In most cases pesticide contamination of ground water can be avoided by using common sense and following label instructions. However, some areas are particularly vulnerable to pesticide contamination and thus require special consideration prior to making an application. The use of this score card may indicate whether an alternative pesticide should be used within a given area or if the area is not suited to pesticide applications.

Several major factors in a particular area determine the relative vulnerability of ground water to pesticide contamination. Nine of these factors were incorporated into the RAVE score card and are defined below and in Chapter 4. Values for these factors were developed on a landscape basis, as defined below. Pesticide leaching potential is based on the soil persistence and herbicide mobility. For this planning effort, a highly leachable herbicide was modeled. This was done to give a "worst case" scenario.

The herbicide picloram (Tordon®) is considered a highly leachable chemical (Montana State University, Extension Service. 1990). It is quite soluble in water, and it is poorly bound to soils. It is also moderately persistent (average of 90 days ½ life.) Degradation by microorganisms is mainly aerobic. Volatilization is low and photochemical degradation occurs only at the soil surface. For these reasons, picloram is used as an index in this evaluation. Because of its moderate ½ life, and high leachability it is not considered a candidate for long-term buildup in soils. However, traces of it can remain in the soil for up to eleven years, so it is important to carefully consider application rates (Rew, Lisa, PhD, Montana State University, personal communication 2003 as cited in Gallatin National Forest FEIS, USFS, 2005).

Factor definitions used in the RAVE score card system.

- *Irrigation Practice:* A rating based on whether a field is flood, sprinkler or non-irrigated.
- *Depth to Ground Water:* The distance, in vertical feet, below the soil surface to the water table.
- *Distance to Surface Water:* The distance, in feet, from the application site to the nearest flowing or stationary surface water.
- *Percent Organic Matter:* The relative amount of decayed plant residue in the soil (most Montana soils are < 3 percent).
- *Pesticide Application Frequency:* The number of times the particular pesticide is applied during one growing season.
- *Pesticide Application Method:* A rating based on whether the pesticide is applied above or below ground.

- *Pesticide Leachability:* A relative ranking of the potential for a pesticide to move downward in soil and ultimately contaminate ground water based upon the persistence, adsorptive potential and solubility of the pesticide.
- *Topographic Position:* Physical surroundings of the field to which the pesticide application is to be made. Flood plain = within a river or lake valley, Alluvial Bench = lands immediately above a river or lake valley, Foot Hills = rolling up-lands near mountains, Upland Plains = high plains not immediately affected by open water or mountains.

All spatial layers were co-located in a geo-database. Ratings for the factors listed above were assigned to soil survey map units (USDA, 1971, 1975, and 1988). These were spatially joined to the buffered stream and lake layers to rate depth to ground water. All rankings were totaled and classified as described below for risk categories. The resulting layer was limited to the Custer National Forest boundary. The resulting tables were queried to provide risk classification summaries by Districts and Forest. All spatial data and analytical procedures are located in the project file.

The RAVE score card rates aquifer vulnerability on a scale of 30 to 100 for individual application sites and pesticides. Higher values indicate high vulnerability of ground water to contamination by the pesticide used in the evaluation. Those values greater than or equal to 65 indicate a potential for ground water contamination. In such instances when broadcast spraying, alternative pesticides should be sought which have a lower leaching potential (see Table 3 -13 for leachability). Scores of 80 or greater indicate that pesticide broadcast applications should not be made at this location unless an alternative product greatly reduces the score. Scores between 45 and 64 indicate a moderate to low potential for ground water contamination and scores less than 45 indicate a low potential for ground water contamination by the pesticide in question. Even in such cases, careful use of pesticides and following label instructions is imperative to protect ground water. The following table describes risk classes.

TABLE 3 - 12. RISK CLASSES FOR HERBICIDE/GROUNDWATER AQUIFER CONTAMINATION

RAVE Rating Score	Risk Class
< 45	Low
45-64	Low to moderate
65-79	High
80-100	Unacceptable

Soils and Ground Water - Affected Environment

Because of the relatively low proportion of weeds on the Custer Forest, there has not been a large soil effect from their incursion. Of 1.2 million acres, less than 1,500 net acres have weed infestations. However, it is important to keep these values low to prevent soil degradation and erosion.

Other recent EIS documents (Gallatin National Forest FEIS, USFS, 2005. Helena National Forest DEIS, USFS, 2003 and Beaverhead-Deerlodge National Forest EIS 2002), incorporated by reference, have addressed the effects of weeds on soil organic matter, soil water interactions, soil evaporation rates, soil erosion, soil biota, and soil nutrients. The amount of impact is proportional to the amount of weeds. These documents also addressed the effects of herbicide on soil productivity. The Beaverhead-Deerlodge Noxious Weeds EIS stated that adverse effects of soil quality or productivity could not be detected (USFS 2002, page 3-43). They cited annual or semi-annual herbicide treated knapweed infested areas have lower knapweed cover and higher native grass cover than observed untreated knapweed stands. This agreed with studies elsewhere (USFS 2002 (HNF DEIS). Since these documents did not find a measurable effect on projects that involved more acres (Helena National Forest proposed treatment on 23,000 acres, and the Beaverhead - Deerlodge National Forest proposed treatment on 16,000 acres) it is logical to assume that there will be no measurable effect with this proposed project. Consequently, the effects of weeds and herbicides on soil productivity will not be repeated in this document, rather they will be incorporated by reference (see soil analysis in project file).

HERBICIDE DEGRADATION AND ENVIRONMENTAL FATE

The following discussion on herbicide degradation and environmental fate is references the Gallatin National Forest Noxious and Invasive Weed Treatment Environmental Impact Statement (USDA FS, 2005) and is hereby incorporated into this analysis by reference.

Pesticide applicators of today are faced with growing concern over the potential for pesticide contamination of ground water. A large percentage of Montanan's and South Dakotan's consumes ground water as their source of drinking water. Protecting this fragile resource from pesticide contamination is imperative, because some pesticides may be harmful to humans at very low concentrations and clean-up of ground water is extremely difficult. Pesticide residues in ground water may also adversely affect sensitive crops and wildlife.

There are several ways for herbicides to damage resources. These include buildup in the soil, contamination of groundwater through infiltration, and surface runoff to streams. This analysis deals only with groundwater contamination and buildup. Other models are used to predict surface water contamination by runoff (see the following the water quality section).

Caution must be taken to avoid long-term buildup of herbicides in soils. Not only could they approach toxic levels, they may become more susceptible to movement and contamination as concentrations increase. Several processes affect persistence in soils. These include transport (volatilization, leaching, runoff, and erosion), adsorption and partition (immobilization by soil components), transformation (degradation by biological, photochemical, or other chemical processes), and plant processes (uptake, metabolization, immobilization.)

Herbicides vary in their persistence, but generally have short "half-lives" (the period of time it takes for one-half of the amount of pesticide in the soil to degrade. Each half-life that passes reduces the amount of pesticide present in the soil by one-half, i.e. 1 to 1/2 to 1/4 to 1/8 to 1/16, etc.). This measure is a result of those processes described above with the exception of removal. Pesticides can be categorized on the basis of their half-life as non-persistent, degrading to half the original concentration in less than 30 days; moderately persistent, degrading to half the original concentration in 30 to 100 days; or persistent, taking longer than 100 days to degrade to half the original concentration. A "typical soil half-life" value is an approximation and may vary greatly because persistence is sensitive to variations in site, soil, and climate.

Table 3 - 13 is an abridged version of the Oregon State University Extension Pesticide Properties Database[18] which outlines four parameters describing pesticide behavior in soils. Columns include a 'Pesticide Movement Rating' derived from the typical soil half-life value, the solubility of the herbicide in water, and the soil sorption coefficient. The movement rating provides a sense of the potential for a given herbicide to move towards groundwater, rather than a precise characterization that could be used for comparative purposes. There are too many variable factors that influence soil half-life and soil sorption to allow for a precise prediction of the behavior of an herbicide in the soil.

---

[18] OSU Extension, 1994 http://www.npic.orst.edu/ppdmove.htm and OSU Extension, 1999 http://eesc.orst.edu/agcomwebfile/edmat/html/EM/EM8561/EM8561.html ; USDA FS, 2005. Inyo NF, Inyo National Forest Integrate Weed Mangement EA; MT, UT, WY Ext., 2002; MSU Extension, 2005.

TABLE 3 – 13. HERBICIDE BEHAVIOR IN SOILS

Common Name	Trade Name	Pesticide Movement Rating (Leachability)[19]	Soil Half-life (days) (Persistence)	Water Solubility (mg/l) (Surface Loss Potential)[20]	Sorption Coefficient (soil Koc)[21]
2,4-D acid	Weedar,	Moderate leachability	10 Non-persistent	890	20
2,4-D esters or oil sol. amines	Weed RHAP	Moderate leachability	10 Non-persistent	100	100
Aminopyralid	Milestone	Moderate leachability	34 Moderately Persistent	205,000	10.8
Chlorsulfuron	Glean	High leachability	40 Moderately persistent	7000	40
Clopyralid amine salt	Transline	Very High leachability	20 Moderately persistent	300,000	6
Dicamba salt	Banvel	Very High leachability	14 Non-persistent	400,000	2
Diuron	Karmex, Diurex, Direx	Moderate leachability	90 Moderately persistent	42	480
Glyphosate isopropylamine salt	Accord, Rodeo, Roundup	Extremely Low leachability	30 Moderately persistent	900,000	24,000
Hexazinone	Velpar	Very High leachability	60 Moderately persistent	33,000	54
Imazapic	Plateau	High leachability	120 Highly persistent	206	7-267
Imazapyr acid	Arsenal, Chopper, Contain	High leachability	90 Moderately persistent	11,000	100
Imazapyr isopropylamine salt	Arsenal, Chopper, Contain	High leachability	90 Moderately persistent	500,000	100
Metsulfuron-methyl	Escort Ally	High leachability	30 Moderately persistent	9500	35
Picloram salt	Tordon	Very High leachability	90 Moderately persistent	200,000	16
Sulfometuron-methyl	Oust	Moderate leachability	20 Non-persistent	70	78
Triclopyr ester	Garlon4,Garlon 3A	Low leachability	46 Moderately persistent	23	780

[19] The Pesticide Movement Rating is categorically derived from the Groundwater Ubiquity Score (GUS), which is GUS = log10 (half-life) x [4 - log10 (Koc)]. Movement ratings range from 'Extremely Low' to 'Very High'. Pesticides with a GUS less than 0.1 are considered to have an extremely low potential to move toward groundwater. Values of 1.0-2.0 are low, 2.0-3.0 are moderate, 3.0-4.0 are high, and values greater than 4.0 have a very high potential to move toward groundwater.

[20] Water solubility describes the amount of pesticide that will dissolve in a known amount of water. Most of the values reported were determined at room temperature (20° C or 25° C). The higher the solubility value, the more likely the pesticide will be removed from the soil in runoff or by leaching.

[21] The sorption coefficient (Koc) describes the tendency of a pesticide to bind to soil particles. Sorption retards movement of the pesticide through soil, and may also increase persistence (increase the half-life) because the pesticide is protected from degradation processes. The higher the Koc value, the greater the tendency for a pesticide to bind to the soil.

WATER QUALITY, FISHERIES, AND AMPHIBIANS

Water Quality, Fisheries, and Amphibians - Regulatory Framework

Clean Water Act: This Act requires Federal Agencies to comply with all Federal, State, and local requirements, administrative authority, process and sanctions related to the control and abatement of water pollution (CWA, Sections 313(a) and 319(k)). The Act gives authority to individual States to develop, review, and enforce water quality standards under Section 303. This section also requires the States to identify existing water bodies that do not meet water quality standards, and develop plans to meet them. These plans are commonly called TMDLs, which stands for total maximum daily load.

Montana Water Quality Law: The Beartooth District of the Custer National Forest is classified as B-1 waters by the Montana Department of Environmental Quality (ARM 16.20.611). The western portion of the Ashland District (Tongue River) is classified as B-2 waters. The associated beneficial uses of B-1 and 2 waters are drinking, culinary and food processing purposes and conventional treatment: bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl, furbearers, and other wildlife; and agricultural and industrial water supply (ARM 17.30.623 & 624).

The eastern portion of the Ashland District (Powder River) and the Montana portion of the Sioux District are classified as C-3 waters (ARM 16.20.611 & 612). The associated beneficial uses of C-3 waters are: bathing, swimming, and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers. The quality of these waters is naturally marginal for drinking, culinary and food processing purposes, agricultural and industrial water supply. Degradation which will impact established beneficial uses will not be allowed. (ARM 17.30.629).

Two of the most applicable surface water quality standards for streams on the Custer National Forest include 1) a maximum allowable increase in naturally occurring turbidity of five (B-1 waters) or ten (C-3 waters) nephelometric turbidity units (NTU); and 2) no increases are allowed above naturally occurring concentrations of sediment, settleable solids, oil, or floating solids, which will or are likely to create a nuisance or render the water harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife (ARM 17.30.623 & 629).

West Fork Rock Creek was historically a is a municipal watershed for the city of Red Lodge. Even though the city no longer uses the intake (it now uses a well for their source of water), the watershed is still and classified as A-1 waters. A-1 classification standards are the most stringent of those discussed and specific to maintaining water quality for domestic uses after conventional treatment.

It is important to understand that many herbicides are toxic to aquatic life even though numerical aquatic life criteria have not been established by Montana or South Dakota. The Montana Water Quality Standards, however, do include a general narrative standard requiring surface water to be free from substances that create concentrations which are toxic or harmful to aquatic life.

In Montana, numeric water quality standards (MDEQ 2004) for human health water quality standards and herbicides that could be use in the Forest are listed in the table below.

TABLE 3 - 14. MONTANA WATER QUALITY HUMAN HEALTH STANDARDS FOR HERBICIDES[22]

Common Name	Category	Human Health Standards		Required Reporting Value[23] micro-grams/liter
		Surface Water micro-grams/liter	Groundwater micro-grams/liter	
2,4-D	Toxin	70	70	1
Aminopyralid	Not Listed	Not Listed	Not Listed	Not Listed
Chlorsulfuron	Toxin	15	15	No Set Standard
Clopyralid	Toxin	3,500	3,500	No Set Standard
Dicamba	Toxin	200	200	No Set Standard
Diuron	Toxin	10	10	No Set Standard
Glyphosate	Toxin	700	700	50
Hexazinone	Toxin	400	400	No Set Standard
Imazapic	Not Listed	Not Listed	Not Listed	Not Listed
Imazapyr	Toxin	21,000	21,000	No Set Standard
Methsulfuron methyl	Toxin	1,750	1,750	No Set Standard
Picloram	Toxin	500	500	1
Sulfometuron methyl	Toxin	1,750	1,750	No Set Standard
Triclopyr	Toxin	350	350	No Set Standard

The Montana Water Quality Act, Nondegradation Rules, and Surface Water Quality Standards require that land management activities must not generate pollutants in excess of those that are naturally occurring, regardless of the stream's classification. "Naturally occurring means conditions or material present from runoff or percolation over which man has no control or from developed lands where all reasonable land, soil and water conservation practices have been applied." "Reasonable land, soil and water conservation practices means methods, measures or practices that protect present and reasonably anticipated beneficial uses" (ARM 17.30.602) and are commonly called Best Management Practices (BMPs). Best management practices are considered reasonable only if beneficial uses are protected. The Forest Service will utilize the protection measures identified in Chapter 2 to ensure compliance with State Water Quality Laws.

Section 303(d) of the federal Clean Water Act directs states to list water quality impaired streams and develop "total maximum daily loads" (TMDLs) for the affected stream segment. The 2004 Montana DEQ 303(d) List identifies one stream segment adjacent to the Custer National Forest as needing a TMDL: Hanging Woman Creek, north of Birney. The probable cause for stream impairment is siltation, and the probable source is grazing related. Herbicide is not identified as a cause for impairment. The 2004 List also indicates that 14 stream segments on or adjacent to the Custer National Forest have insufficient data to assess some or all uses and therefore require reassessment to determine beneficial use support. A list, map, and impairment specifics as well as a description of the Montana DEQ 303(d) process are located at: http://nris.state.mt.us/wis/environet/2002_303dhome.html.

South Dakota Water Quality Law: Beneficial use classification for all streams in the South Dakota portion of the Sioux District include (6) warm water marginal fish life propagation waters, and (8) limited contact recreation waters (South Dakota Administrative Rules (SDAR), Surface Water Quality Standards, 74:51:03:02, 19 & 22). Warmwater marginal fish life propagation is defined as "a beneficial use assigned to surface waters of the state which will support aquatic life and more tolerant species of warmwater fish naturally or by frequent stocking and intensive management but which suffer frequent fish kills because of critical natural conditions" (SDAR 74:51:01:01 (60)).

The most applicable surface water quality standards for streams in South Dakota include:

[22] MT DEQ, January 2004 (http://www.deq.state.mt.us/wqinfo/Circulars/WQB-7.PDF).

[23] Required Reporting Value is the Department of Montana best determination of a level of analysis that can be achieved in routine sampling. It is based on levels actually achieved at both commercial and government laboratories in Montana using accepted methods. The Required Reporting Value is the detection level that must be achieved in reporting ambient or compliance monitoring result to the Department. Higher detection levels may be used if it has been demonstrated that the higher detection levels will be less than 10% of the expected level of the sample.

Compliance with criteria for beneficial use. A person may not discharge or cause to be discharged into surface waters of the state pollutants which cause the receiving water to fail to meet the criteria for its existing or designated beneficial use or uses (SDAR 74:51:01:02).

Biological integrity of waters. All waters of the state must be free from substances, whether attributable to human-induced point source discharges or nonpoint source activities, in concentrations or combinations which will adversely impact the structure and function of indigenous or intentionally introduced aquatic communities (SDAR 74:51:01:12).

Antidegradation of waters of the state. The antidegradation policy for this state is as follows (SDAR 74:51:01:34):

- The existing beneficial uses of surface waters of the state and the level of water quality that is assigned by designated beneficial uses shall be maintained and protected;
- Surface waters of the state in which the existing water quality is better than the minimum levels prescribed by the designated beneficial use shall be maintained and protected at that higher quality level;
- The board, or secretary, may allow a lowering of the water quality to levels established under the designated beneficial use if it is necessary in order to accommodate important economic or social development in the area in which the waters are located;
- Surface waters of the state which do not meet the levels of water quality assigned to the designated beneficial use shall be improved as feasible to meet those levels;
- No further reduction of water quality may be allowed for surface waters of the state that do not meet the water quality levels assigned to their designated beneficial uses as a result of natural causes or conditions, and all new discharges must meet applicable water quality standards; and
- The secretary shall assure that regulatory requirements are achieved for all new and existing point sources and that nonpoint sources are controlled through cost effective and reasonable best management practices.

The criteria for warm water marginal fish life propagation and recreation waters and their allowable variations that are not included under South Dakota Administrative Rules 74:51:01:55 and its corresponding Appendix B, unless set under § 74:51:01:24, (http://legis.state.sd.us/rules/rules/7451.htm). Numeric water quality standards specified to herbicides have not been established for South Dakota.

The 2002 South Dakota 303(d) List does not identify any stream segments on or adjacent to the Custer National Forest as impaired. However, two segements located well below the Forest boundary are listed. These include the lower reaches of the South Fork Grand River and Moreau River.

Presidential Executive Order 12962: Presidential Executive Order 12962, signed June 7, 1995, furthered the purpose of the Fish and Wildlife Act of 1956, the National Environmental Policy Act of 1969, and the Fish and Wildlife Coordination Act, seeking to conserve, restore, and enhance aquatic systems to provide for increased recreational fishing opportunities nationwide. This order directs Federal agencies to "improve the quantity, function, sustainable productivity, and distribution of aquatic resources for increased recreational fishing opportunity by evaluating the effects of Federally funded, permitted, or authorized actions on aquatic systems and recreational fisheries and document those effects relative to the purpose of this order."

Cooperative Conservation Agreement for Yellowstone Cutthroat Trout within Montana and Land-use Strategy for Implementation of the 1999 Memorandum of Understanding and Conservation Agreement for Westslope Cutthroat Trout in Montana: The Custer National Forest is an active cooperator in The Cooperative Conservation Agreement for Yellowstone Cutthroat Trout within Montana (CCA). The long term goal of the CCA is to ensure the long term persistence of the Yellowstone cutthroat trout subspecies within its historic range in Montana at levels and under conditions that provide for protection and maintenance of both intrinsic and recreational values associated with this fish. The Memorandum of Understanding and Conservation Agreement (MOUCA) for Westslope Cutthroat Trout in Montana (adopted by the Custer and Gallatin National Forests for Yellowstone cutthroat trout populations) includes as objectives 1) to protect all pure and slightly introgressed (90 percent or greater purity)

populations; and 2) to ensure their long-term persistence within their native range. The Land-use Strategy for Implementation of the 1999 MOUCA in Montana adopted by the Forest Service and Bureau of Land Management in 2002, further defines how the MOUCA will be implemented by federal land management agencies. For new activities, the Strategy stipulates that the Forest Service will 1) provide watersheds supporting conservation populations with the level of protection necessary to ensure their long-term persistence; 2) defer any new federal land management action if it cannot be modified to prevent unacceptable aquatic/riparian habitat degradation; and 3) maintain cutthroat trout habitat at 90 percent of optimum habitat conditions. When this 90 percent of optimum condition criteria is not met, only activities resulting in habitat improvement are to be considered. The Strategy also states that Forest Service Biological Evaluations (FSM 2670) prepared for new activities should, in most cases, conclude that there will be a beneficial effect or no effect to the cutthroat trout population or its habitat.

Forest Plan: The Custer N.F. Plan provides the following direction for weed treatment and herbicide application in relation to water and aquatic resources:

Chapter II, E. Management Standards, 5. Range, e. Noxious Farm Weed Control,

1) Utilize an integrated pest management approach to control infestations.
2) Prioritize control efforts.
3) Use only approved chemicals and avoid chemical use in areas where significant impact is expected on water resources, key wildlife habitat or unique vegetation.
4) Utilize proven biological control over chemical control where available.
5) Coordinate and cooperate with county weed boards.
6) Monitor treatments for effectiveness.
7) Allow only certified, weed free hay or palletized feed where hay use for recreation purposes is allowed.

Chapter III, Management Area Direction, Management Area M (Riparian), 3. Range,

e. Noxious weed control through chemical application will be evaluated by an appropriate NEPA process and done by hand application to individual plants within 50 feet of riparian zones and open water.

The Custer National Forest possesses a diversified fisheries resource. High mountain lakes and cold mountain streams support abundant recreational and native salmonid populations, whereas small impoundments and prairie streams in pine hill and grassland regions support numerous warm water fish species.

Goals of the Custer National Forest Plan as they relate to fisheries include: 1) to manage fisheries through habitat improvement and coordination with state agencies, 2) increasing fisheries potential through protection of existing habitats and development of improvement projects, 3) increasing the quantity and quality of fish habitats on Custer National Forest lands, and 4) to maintain or expand the range of native Yellowstone cutthroat trout (USFS 1986, pages 124,154).

SENSITIVE FISH AND AMPHIBIAN SPECIES

Sensitive species are those animal species identified by a Regional Forester for which population viability is a concern as evidenced by a significant current or predicted downward trend in population numbers, density, or in habitat capability that will reduce a species' existing distribution (FSM 2670.5.19). There are four amphibian and three fish species listed as sensitive for the Custer National Forest which are discussed in this section.

Protection of sensitive species and their habitats is a response to the mandate of the National Forest Management Act (NFMA) to maintain viable populations of all native and desired non-native vertebrate species (36 CFR 219.19). The sensitive species program is intended to be pro-active by identifying potentially vulnerable species and taking positive action to prevent declines that will result in listing under the Endangered Species Act.

As part of the National Environmental Policy Act (NEPA) decision-making process, proposed Forest Service programs or activities are to be reviewed to determine how an action will affect any sensitive species (FSM 2670.32). The goal of the analysis should be to avoid or minimize impacts to sensitive species. If impacts cannot be avoided, the degree of potential adverse effects on the population or its habitat within the project area, and on the species as a whole, needs to be assessed.

Published reports in scientific journals were reviewed along with file data from the Custer National Forest, unpublished reports, and personal communications. Information on ecology, distribution, and habitat affinities for sensitive species was also obtained online from the 1) Montana Natural Heritage Program Database; 2) Montana Chapter of the American Fisheries Society; and 3) Montana Department of Fish, Wildlife and Parks (http://nhp.nris.state.mt.us/animalguide, http://www.fisheries.org/AFSmontana/SSCpages, http://fwp.state.mt.us/fieldguide).

Great Plains Toad *(Bufo cognatus)*

The Great Plains toad (*Bufo cognatus*) is recognized as a distinct species, ranging across the Great Plains from central Mexico to southeastern Alberta and in the desert southwest as far west as eastern California and as far north as southern Utah at elevations up to 2,440 M (8,000 ft) (Stebbins 1985; Goebel 1996; as reported in Maxell 2000). The Great Plains toad inhabits the eastern plains of Montana, especially on the plateaus between and flanking the Yellowstone and Missouri Rivers (Werner et al. 2004).

Great Plains toads inhabit upland grasslands and upper reaches of drainages. They are often observed in glacial potholes, stock reservoirs, irrigation ditches, and small coulees, and spend considerable time underground in self-excavated burrows (Maxell 2000; Werner et al. 2004). Adults feed nocternally and during rainy days (Werner 2004). Diets consists primarilly of small terrestrial arthropods, ants, termites, and beetles (Maxell 2000; Werner et al. 2004). Great Plains toads reach sexual maturity in 2 to 5 years (Maxell 2000) and can hybridize with Woodhouse's toads (*Bufo woodhousii*); the hybrids can resemble either species (Werner et al. 2004). Breeding occurs in clear shallow temporary pools, marshes, and reservoirs in late spring and summer, often after heavy precipitation events (Maxell 2000; Werner et al. 2004). Indivduals may not breed during periods of severe drought (Werner et al. 2004). Eggs are often laid communally and hatch in two to three days; tadpoles undergo metomorphosis three to six weeks after hatching (Maxell 2000; Werner et al. 2004).

Great Plains toads have been documented at about 30 localities across the plains east of the Rocky Mountains in the past 150 years and their status across this region is almost completely unknown (Maxell 2000). Although the historic distribution of the Great Plains toad includes portions of the Custer National Forest (CNF), only two historic records exist from areas adjacent to and no sightings have been documented on CNF lands in eastern Montana (Hendricks and Reichel 1996).

Plains Spadefoot (*Spea bombifrons*)

A single distinct species of plains spadefoot (*Spea bombifrons*) is recognized as ranging across the Great Plains from northern Mexico to southern Canada at elevations up to 2,440 M (8,000 ft) (Stebbins 1985; Wiens and Titus 1991; as reported in Maxell 2000). In Montana, despite large distribution gaps between the Missouri and Musselshell rivers, the plains spadefoot is found east of the Continental Divide in intermountain valleys (around Dillon, Bozeman and Helena) and east across the prairies (MTFWP 2005)

This species is often found in areas with soft sandy soils near permanent or temporary bodies of water. The plains spadefoot is seldom encountered outside of the bredding season since they spend most daylight hours undergound (Werner et al. 2004). For much of each year it lives largely inactive in burrows of its own construction or occupies rodent burrows, and enters water only to breed (MTFWP 2005). Breeding occurs between May and July in shallow temporary pools and is usually initiated by significant rainfall and temperatures above 12 °C (Hendricks and Reichel 1996; Werner et al. 2004). Two morphologies are commonly observed in tadpoles: 1) omnivores which feed on phytoplankton and detritus, and 2) carnivores which feed on fresh water shrimp, other invertebrates, and frequently their own or other amphibian larvae (Maxell 2000). Adults mostly feed on insects (Werner et al. 2004). Juveniles and adults

may disperse distances over 2 kilometers from breeding ponds (Klassen 1998; as reported in Maxell 2000).

The plains spadefoot is sparsely documented in central and eastern Montana, including a few sightings in the mountain valleys of the upper Missouri watershed (Werner et al. 2004). However, plains spadefoot sightings are documented to the east, north, and west of the Ashland District, Custer Natioanl Forest (Reichel 1995; as reported in Hendricks and Reichel 1996). Therefore, the plains spadefoot likley occurs on Forest lands in eastern Montana; Hendricks and Reichel (1996) recommended watching for the species in prairie or shrub-steppe habitat on the Ashland District.

Northeren Leopard Frog (*Rana pipiens*)

The northern leopard frog (*Rana pipiens*) historically ranged from Newfoundland and northern Alberta in the north to the Great Lakes region, the desert Southwest and the Great Basin in the south (Maxell 2000). A number of isolated populations historically existed in the Pacific Northwest and California (Stebbins 1985). In Montana they have been documented across the eastern plains and in many of the mountain valleys on both sides of the Continental Divide at elevations up to 6,700 feet (Werner et al. 2004).

The northern leopard frog is found in and adjacent to permanent slow moving or standing water bodies with considerable vegetation, but may range widely into moist meadows, grassy woodlands and even agricultural areas (Nussbaum et al. 1983). Adults feed on invertebrates, but may cannibalize smaller individuals. Adults overwinter on the bottom surface of permanent water bodies, under rubble in streams or in underground crevices that do not freeze. Northern leopard frogs breed from mid-March to early June (Maxell 2000). Mating occurs when males congregate in shallow water and begin calling during the day (Maxell 2000). Eggs are laid at the water surface in large, globular masses of 150 to 500 (Maxell 2000). Juveniles may move as much as 8 kilometers from their natal ponds to their adult seasonal territories (Dole 1971; Seburn et al. 1997). Young and adult frogs often disperse into marsh and forest habitats, but are not usually found far from open water (Maxell 2000).

Over the last few decades the northern leopard frog has undergone declines across much of the western portion of their range (Stebbins and Cohen 1995; as reported in Maxell 2000). Most northern leopard frogs in western Montana became extinct in the 1970's or early 1980's. The only 2 population centers known to exist in western Montana are near Kalispell and Eureka (Maxell 2000). However, the northern leopard frog is still abundant and widespread in southeastern Montana and northwestern South Dakota (Reichel 1995; as reported in Hendricks and Reichel 1996). This species was encountered at seven locations in 1995 on the Ashland District of the Custer National Forest, but breeding was confirmed at only one of the sites (Hendricks and Reichel 1996). The northern leopard frog is a sensitive species on all Region 1 Forests.

Western Toad (*Bufo boreas)*

The western toad (*Bufo boreas)* is currently recognized as two subspecies ranging from the Rocky Mountains to the Pacific Coast and From Baja Mexico to southeast Alaska and the Yukon Territory (Stebbins 1985; as reported in Maxell 2000). They are found in a variety of habitats, including wetlands, forests, sagebrush meadows and floodplains. Western toads inhabit all types of aquatic habitats ranging from sea level to 12,000 ft in elevation (Maxell 2000). The subspecies of western toad found in Montana is the boreal toad (*Bufo boreas boreas*).

Adult and juvenile toads are freeze intolerant and overwinter and shelter in underground caverns, or rodent burrows (Maxell 2000). Adults feed on a variety of ground dwelling invertebrates and are known to eat smaller individuals of their own species. Adults must utilize thermally buffered microhabitats during the day, and can be found under logs or in rodent burrows (Maxell 2000). Because of their narrow environmental tolerance (10-25 $^{\circ}C$ throughout the year), adults are active at night and can be found foraging for insects in warm, low-lying areas (Maxell 2000). Breeding typically occurs from May to July in shallow areas of large and small lakes, ponds, slow moving streams and backwater channels of rivers (Black 1970; Metter 1961; as reported in Maxell 2000). Tadpoles metamorphose in 40 to 70 days and can be found in dense aggregations adjacent to breeding grounds (Werner et al. 2004).

In the northern Rocky Mountains western toads have undergone declines. Surveys in the late 1990's revealed they were absent from a number of areas they historically occupied. While they remain widespread across the landscape, they appear to be occupying only 5 –10%, or less, of the suitable habitat (Maxell 2000). Based on these findings the USFS listed the western toad as sensitive in all of Region 1's National Forests, and initiated a regional inventory in Montana. As a result, a systematic inventory of standing water bodies in 40 randomly chosen 6th level hydrologic unit code (HUC) water sheds was completed, across western Montana, during the summer of 2000. Results indicated they were widespread, but extremely rare. Western toads have been found on the Beartooth Plateau, Custer National Forest, at altitudes as high as 9,200 ft (Werner et al. 2004).

Activities on National Forest lands that may pose a risk to population viability of amphibian species include: timber harvest, grazing, fire and fire management activities, nonindigenous species and their management, road and trail development, on and off road vehicle use, development and management of water impoundments and recreational facilities, the impact of habitat loss and fragmentation on regional sets of populations or metapopulations, and impacts of weeds and weed and pest management activities (Maxell 2000; Werner et al 2004).

Northern Redbelly Dace (*Phoxinus eos*)

The northern redbelly dace (*Phoxinus eos*) is a cyprinid fish native to Montana. The species persists in the lower Missouri River drainage and in tributaries of the lower Yellowstone River basin in Montana (MTNHP 2005). Northern redbelly dace are found from British Columbia and the Northwest Territories across southern Canada to Nova Scotia, and are widely distributed in the north half of North America, from the Rocky Mountain front to the East Coast.

Northern redbelly dace prefer clear, cool, slow-flowing creeks, ponds and lakes with aquatic vegetation, including filamentous algae. During the spawning season (May through August), this species becomes quite colorful with red flanks (MTFWP 2005). This species is sexually mature at 1 year and females may spawn twice each year. Spawning takes place on clumps of filamentous algae; during spawning episodes, 5 to 30 non-adhesive eggs are released and become entangled in the algal filaments. Incubation occurs in 8 to 10 days at 20 to 27 °C (MTNHP 2005). Maximum size is about 3 inches (MTFWP 2005). Their diet consoisits of plant material, including diatoms and filamentous algae, as well as zooplankton, aquatic insects, and occasionally fish. The northern redbelly dace hybridizes with the finescale dace (*Phoxinus neogaeus*) in some locations in the northern United States and Canada (MTFWP 2005). Resultant hybrids are all females and produce offspring that are also all female (MTNHP 2005). Eggs from the hybrids are "fertilized" by the sperm of northern redbelly dace and it appears that "fertilization" is necessary for egg development to begin; none of the genetic traits of the male are incorporated into the fertilized embryo (MTFWP 2005).

The northern redbelly dace is considered common and abundant in the state of Montana (MTFWP 2005). However, Northern redbelly dace are listed as sensitive species in Region 1 and by the state of South Dakota. Although there is no record of the species on Custer National Forest lands within South Dakota, headwater streams originating on National Forest lands are suspected to support northern redbelly dace populations historically; current distribution data within the state is limited.

Sturgeon Chub *(Macrhybopsis gelida)*

The sturgeon chub (*Macrhybopsis gelida*) is a cyprinid fish indigenous to the Missouri and Mississippi river basins (Gould 1998). Due to suspected low numbers in Montana waters, the sturgeon chub was designated as a state species of special concern over two decades ago (Holton 1980; as reported in Gould 1998). However, recent collections of sturgeon chub in Montana revealed that it is more widespread and abundant than previously understood. The species are present in the Powder River, lower Yellowstone River, and the mid-Missouri River (Gould 1998; USFWL 2001). The historic record of sturgeon chub abundance and distribution in South Dakota is limited (USFWL 2001). Although considered abundant in the White River (Cunningham 1999), the species is regarded as rare in South Dakota; low numbers of sturgeon chub have been detected in the Cheyenne and Little White rivers (USWFL 2001).

Sturgeon chub are typically found in free flowing riverine systems, characterized by highly variable flow regimes, bradied channels, sand/fine gravel substrates, and high turbidity (USFWL 2001). Food habits are largely unknown unknown, but the ventral mouth and short intestine indicate they feed on bottom-dwelling insects. Sturgeon chubs attain a maximum length of about 4 inches (MTFWP 2005). Sexuall maturity is thought to be achieved at age 2 or older. Spawning is believed to occur in spring, coresponding to water temperature ranging from 20 to 25 °C (USFWL 2001).

Sturgeon chub are listed as sensitive fish species in the states of Montana and South Dakota. Custer National Forest (CNF) lands in Montana and South Dakota are within the native range of the sturgeon chub. This species has never been documented on CNF lands and requires rapid, turbid waters of plains streams larger than most streams found on National Forest in these areas. However, limited information exists on native warm water fish's distributions on CNF lands in headwater tributaries to larger prairie streams.

Yellowstone Cutthroat Trout (*Oncorhynchus clarki bouvieri*)

Yellowstone cutthroat trout (*Oncorhynchus clarki bouvieri*), a member of the family Salmonidae, were first described by C. E. Bendire in 1882 based on a sample from a population in Waha Lake, Idaho; however, many explorers had made earlier observations of this subspecies in Montana and Wyoming (Behnke 1992; May 1996; as reported in Young 2001). Yellowstone cutthroat trout (YCT) historically occupied approximately 17,397 miles of habitat in the western U.S., including, from east to west, the upper portions of the Yellowstone River drainage within Montana and Wyoming and the upper Snake River drainage in Idaho, Wyoming, Nevada and Utah (Behnke 1992; as reported in May et al. 2003). In Montana, YCT were historically widely distributed throughout the upper Yellowstone River basin and its tributary streams, ranging as far downstream as the Tongue River (MTFWP 2005).

Yellowstone cutthroat trout inhabit relatively clear, cold stream, river, and lake environments (Young 2001). Spawn typically occurs in spring and early summer, after flows have declined from their seasonal peak, in sites with suitable substrate (gravel less than 85 mm in diameter), water depth (9-30 cm), and water velocity (16-60 cm/s) (Varley and Gresswell 1988; Byorth 1990; Thurow and King 1994; as reported in Young 2001). Upon emergence, fry immediately begin feeding, typically in nearby stream margin habitats, but they may also undertake migrations to other waters (Gresswell 1995; as reported in Young 2001). Sexual maturity is generally achieved by age 3 or older. Yellowstone cutthroat trout and rainbow trout readily hybridize, producing fertile offspring; sympatric populations often form hybrid swarms (Allendorf and Leary 1988; Henderson et al. 2000; as reported in Young 2001).

Yellowstone cutthroat trout exhibit three primary life history patterns: resident, fluvial, and adfluvial (Gresswell 1995; as reported in MTFWP 2005). Resident lifeforms occupy home ranges entirely within relatively short reaches of streams; fluvial fish migrate from larger streams or rivers to smaller streams to reproduce; adfluvial life history forms of YCT exhibit a similar pattern, but migrate, sometimes many kilometers, as mature adults from lakes to inlet or outlet streams to spawn (Young 2001).

Throughout their historic range, YCT trout have undergone substantial declines in distribution and abundance (Young 2001). Genetically unaltered YCT occupy about 7 to 25% of historical habitats (May et al. 2003). The distribution of stream resident YCT on the Custer National Forest is restricted from its historic range, with five known, genetically pure YCT populations currently occupying less than 18 miles of stream habitat. Few (two-six) lake dwelling populations of YCT are thought to have existed in Montana historically (MTFWP 2000). At present, a purported 179 lakes likely support pure populations in Montana (118 of these lakes reside in the Absaroka-Beartooth Wilderness Area; MTFWP 2000). Most current stream populations of YCT are at risk from either hybridization or demographic or stochastic influences (MTFWP 2005).

Water Quality, Fisheries, and Amphibians - Affected Area

Spatial Bounds

Aquatic environments in forested ecosystems are heavily influenced by the physical and biological processes within the watershed (Vannote et al. 1980). For this reason the analysis area, for both fish and amphibians, will encompass all watersheds within the project area boundary.

Sensitive fish and amphibian species historically present in the project area include: northern redbelly dace, sturgeon chub, Yellowstone cutthroat trout, boreal toad, Great Plains toad, northern leopard frog, and plains spadefoot.

The distribution of Yellowstone cutthroat trout in Custer National Forest watersheds is restricted from its historic range, with five known, pure strain Yellowstone cutthroat populations currently occupying less than 18 miles of stream habitat. The current distribution of stream resident Yellowstone cutthroat trout is displayed in Table 3 - 15. Cyprind and amphibian species distributions are likely also truncated, although distribution data are limited.

TABLE 3 - 15. WEEDS WITHIN 300' OF YELLOWSTONE CUTTHROAT TROUT STREAMS[24]

5th CODE HUC	Drainage	Stream Name	Gross Acres of Weeds within 300' of Stream (drainage)
1007000502	Limestone Creek	Picket Pin Creek	206
1007000503	Bad Canyon Creek	Bad Canyon Creek	36
1007000609	Rock Creek	Wyoming Creek	544
1008001005	Crooked Creek	Crooked Creek	186
1008001008	Dry Head Creek	Dry Head Creek	0

Temporal Bounds

Because stream fish habitats may continue to be impacted by anthropogenic activities for many decades after the initial disturbance, temporal cumulative effects for fish and fish habitat will span the breadth of known human activity in the project area. Therefore, the temporal bounds for fish and fish habitat are from 1880 to five years after project implementation (year 2011).

Amphibian habitats may also be negatively impacted long after certain types of anthropogenic actions (Maxell, 2000). Therefore, the cumulative effects will be examined for the period for which literature suggests habitat may continue to be impacted: 50 years in the past (1955) and five years into the future (2010).

Land management activities noted as having possible impacts on amphibian and fish species leopard frogs include timber harvest, grazing, fire and fire management activities, non-native species, road and trail development and use, water impoundment, development and use recreational facilities, harvest, noxious weeds and weed management, and habitat fragmentation.

Water Quality, Fisheries, and Amphibians - Analysis Method

The methodology used in this analysis is based on the Beaverhead-Deerlodge National Forest Noxious Weed Control Program Final EIS (2002) and the Gallatin National Forest Noxious Weed FEIS (2005). It is a risk based assessment that identifies watersheds which have the potential to exceed recommended "safe" concentrations of herbicide deemed necessary to protect fish and aquatic life. Water and fish resources were evaluated together because of related impacts from herbicide application for the control of noxious weeds on the Custer National Forest. Due to limited occurrence and extent of perennial flow

[24] Confirmed presence does not indicate uniform distribution in a drainage; for example, most cutthroat populations are fragmented and restricted to drainage headwaters.

regimes on the Ashland and Sioux Districts, this risk assessment is only applied to the Beartooth Ranger District.

Active ingredients in herbicides proposed for use, include 2, 4-D, aminopyralid, chlorsulfuron, clopyralid, dicamba, diuron, glyphosphate, hexazinone, imazapic, imazapyr, metsulfuron methyl, picloram, sulfometuron methyl, and triclopyr. The Custer National Forest Weed Management EIS interdisciplinary team, the Beaverhead-Deerlodge National Forest Noxious Weed Control Program Final EIS (2002) and the Gallatin National Forest Noxious Weed Final EIS (2005) evaluated these herbicide characteristics and toxicities and concluded that picloram tends to be more toxic to aquatic organisms than all other herbicides. With this in mind, picloram was used as a surrogate for all herbicides to assess risks to aquatic species in this analysis. The selection of a "safe" concentration level for fish follows recommendations presented in the USFS Fisheries and Herbicides Work Group Final Findings and Recommendations, (March 8, 2004). The "safe" concentration level chosen is synonymous with a "maximum allowable toxicant concentration" or MATC equaling 0.075ppm. This value was derived by taking 1/20 of 1.5 ppm (the 96 hour LC-50 for cutthroat trout).

The method of risk assessment is as follows:

1) Determine the total amount of picloram to be applied in a given watershed. Total pounds of picloram applied = the application rate (0.25 lbs/acre) X acres treated. Acres treated include all infested acres, plus 35 percent of the proposed aerial treatment polygon acres by 6^{th} HUC watershed.
2) Determine the routing coefficients to be applied to the treatment acres. A conservative approach was used to determine runoff versus infiltration routing coefficients. Half of the treated acres were considered to be runoff dominant sites and half were considered infiltration dominant sites. The final recommendations from the Western Montana Level 2 Team recommend routing coefficients of 0.01 for runoff dominant sites and 0.02 for infiltration dominant sites (USFS 2004). Using a 50/50 conservative approach for determining runoff versus infiltration acres results in a 0.015 coefficient applied to all treated acres.
3) Determine the maximum amount of picloram that could be routed to surface waters. Total pounds of picloram routed = Total pounds applied (from #1) X 0.015.
4) Determine the low flow (Q95, 95 percent of the time flows are greater than) for a given watershed. The Custer National Forest used a regression equation developed by the Gallatin National Forest. This equation was based on flow duration curves developed from daily discharge data from US Geologic Service gauging records of six gauges on and near the Gallatin NF. The equation is Q95 discharge = $0.2143x^{0.893}$, where x is the watershed area in square miles. It has a R^2 value of 0.7149. This equation was applied to watersheds on the Beartooth Ranger District of the Custer National Forest to determine the Q95 low flow for each 6^{th} HUC (hydrologic unit code) watershed. The low flow is used as a worst case scenario as the capacity for dilution is at its lowest point.
5) Determine the maximum probable concentration of herbicide at the mouth of each 6^{th} HUC headwater watershed and lower cumulative watershed where appropriate. Maximum probable concentration = total pounds of picloram routed (from #3) / Q95 flow converted to pounds of water for a 6 hr flow duration (Q95 X 62.43 lbs/cu.ft X 21600 seconds/6hrs).
6) Compare the maximum probable concentration to the recommended safe level of 0.075ppm picloram.
7) Calculate the maximum amount of acres that can be treated while not exceeding the recommended safe level of 0.075ppm picloram. This value includes all application methods.
8) Calculate the maximum percent of aerial polygon that can be treated while not exceeding the recommended safe level of 0.075ppm picloram. This value assumes no ground-based treatment occurs.

The results from this analysis are listed in Chapter 4, Table 4 - 14.

Water Quality, Fisheries, and Amphibians - Affected Environment

Water quality varies tremendously across the Custer National Forest from pristine wilderness streams to headwater prairie streams. Wilderness streams in the Beartooth Mountain Range are generally perennial and support cold water fisheries, while prairie streams have low or discontinuous flow, which support warm water fisheries or amphibians. Water quality is excellent within wilderness areas, but is influenced by

multiple use activities elsewhere. The Custer National Forest contains about 333 miles of perennial streams and 3,713 acres of lakes that are considered fishable, many of which are of national scenic, historic, and recreational significance.

Average precipitation on the Forest varies from 15 to 60 inches a year with about 50 percent as snow in lower elevations and 75 percent at higher elevations. June receives the largest amount of moisture. Precipitation intensity is relatively moderate. The two year-six hour precipitation varies from 0.7 to 1.5 inches (Miller et al. 1973). Winters are long and cold and snow usually remains at the higher elevations in the Beartooth Mountain Range for eight to nine months.

For most of the Custer National Forest, private agriculture (primarily ranching) is located adjacent to the Forest with more extensive irrigation agriculture land use further downstream. Along the Forest boundary of the Beartooth Range, rural housing development is common. Downstream beneficial uses include fish and aquatic life, recreation, irrigation, stock use, public water supply, private water supply, and wildlife. West Fork Rock Creek is classified as a municipal watershed for the city of Red Lodge, although the city now obtains its domestic water from groundwater sources.

A major beneficial use in and downstream of the Custer National Forest is salmonid habitat. The Custer National Forest encompasses headwater tributaries of the Clarks Fork of the Yellowstone and the Yellowstone Rivers. Pristine high mountain lakes provide diverse fishing opportunity throughout the Absaroka-Beartooth Wilderness Area. Several significant tributaries such as East Rosebud Creek, Rock Creek, the Stillwater River, and West Rosebud Creek provide aquatic habitat and fish populations that support the nationally renowned trout fisheries of Montana.

Wetlands are lands in transition between terrestrial and aquatic systems where the water table is at or near the surface of the land and often covered by shallow water. In order to be considered jurisdictional wetlands, the wetland must be saturated, and at least for part of a year, have un-drained hydric soils, and support predominantly hydrophytic vegetation. Wetlands are extremely valuable to recreational users, esthetic quality, and wildlife habitats, and serve important functions such as sediment filtration, flow moderation, nutrient and other pollutant attenuation. They also act as sources of organic energy for adjacent aquatic habitats. In general, wetlands on the Custer National Forest occur in narrow bands along streams and lake shorelines.

SENSITIVE PLANT SPECIES

Sensitive Plants - Regulatory Framework

Forest Service Manual 2670.22 Sensitive Species provides the following direction for sensitive plants:

- Develop and implement management practices to ensure that species do not become threatened or endangered because of Forest Service actions.
- Maintain viable populations of all native and desired nonnative wildlife, fish, and plant species in habitats distributed throughout their geographic range on National Forest System lands.
- Develop and implement management objectives for populations and/or habitat of sensitive species.

Sensitive Plants - Affected Area

The analysis area for sensitive plants includes all vegetation communities in proximity to proposed treatment areas or those habitats where weeds have potential to invade. These plant communities have the potential to be directly or indirectly impacted by weeds and proposed treatment methods.

Sensitive Plants - Analysis Method

Information used came from data on file at the Custer National Forest, literature review, and personal communications with resource specialists with knowledge of vegetation, weed control, and herbicide effects.

Sensitive Plants - Affected Environment

Habitat for 16 sensitive plant species and one watch species exists on the Custer National Forest. Most of the listed sensitive plant species are located in riparian or wetland areas, one species in alpine, and a few species in drier open cover types. All but four are vulnerable to weed infestations and all but one can be vulnerable to herbicide treatments.

Federally listed Threatened and Endangered plant species do not occur on the CNF. Forest Service listed sensitive plant species that are known or suspected to occur on the CNF, along with occurrence by Ranger District, are displayed in Table 3-16.

TABLE 3 - 16. DESCRIPTION OF SENSITIVE PLANT HABITAT

Species	District	Habitat	Habitat Vulnerable to Herbicide Treatment	Habitat Vunerable to Weed Spread
Adoxa moschatellina Musk-root	Beartooth	Grows in moist, mossy areas often in rock crevices and boulder slopes that may provide protection from human activities from 4,400-5,400 feet.	Yes	No
Asclepias ovalifolia Ovalleaf milkweed	Sioux	Sandy, gravelly or clayey soils of prairies and woodlands	Yes	Yes
Astragalus barrii Barr's milkvetch	Ashland	Gullied knolls, buttes, and barren hilltops, often on calcareous soft shale and siltstone.	Yes	Yes
Carex gravida var. gravida Pregnant sedge	Sioux & Ashland	Open woods, often in ravines with deciduous trees, on the plains.	Yes	Yes
Cypridium parviflorum Small Yellow lady's-slipper	Beartooth	Occurs in damp woods, bogs, mossy seeps and moist forest-meadow ecotones from 3,000-6200 feet.	Yes	Yes
Epipactis gigantea Giant Helleborine	Beartooth	In Montana, occurs only around thermal springs, perennial springs with year-round water flow, bogs and fens, and seeps from 2,000-5,750 feet.	Yes	Yes
Eriogonum visherii Dakota buckwheat	Sioux	Barren, often bentonitic badlands slopes and outwashes in the plains.	Yes	No
Gentiana affinis Prairie gentian	Sioux	Wet meadows, shores, springs, seepage areas and low prairie	Yes	Yes
Gentianopsis simplex Hiker's Gentian	Beartooth	Found growing in mountain bogs, meadows and seepage areas from 4,400-8,400 feet. Flowers in July and August.	Yes	Yes
Haplopappus subsquarrosus var. subsquarrosus	Beartooth	Generally found growing between xx and xx feet) in rocky, open areas. Flowers in late July and August. xx sites have been located on the forest.	Yes	Yes
Juncus hallii Hall's Rush	Beartooth	Associated with montane to subalpine meadows, moist to dry meadows and slopes between 6,900-8,400 feet. Flowers in July and August.	Yes	Yes
Primula incana Mealy Primrose	Beartooth	Wet meadows, springs and shores, often where alkaline; calcareous bog meadows; wet meadows & quaking bogs; NOT found in alpine or subalpine areas..	Yes	Yes
Mertensia ciliata Mountain bluebaells	Sioux	Forested slopes-damp thickets in course to medium textured soils. Valley bottoms associated with springs, seeps, and spring fed water courses. Intermediate shade tolerance. Very drought intolerant. Occasionally found in non-wetlands	Yes	Yes
Ranunculus jovis	Beartooth	Sagebrush grasslands to open forest slopes	Yes	Yes

Species	District	Habitat	Habitat Vulnerable to Herbicide Treatment	Habitat Vunerable to Weed Spread
Jove's Buttercup		in the montane and subalpine zones.		
Salix barrattiana Barratt's willow	Beartooth	Found growing in cold, moist soils near or above treeline (6,800-10,500 feet) especially in alpine areas. Fruits in late July or August.	No	No
Shoshonea pulvinata Shoshonea	Beartooth	Grows on open, windswept limestone substrates (in thin, rocky soils) along ridges and canyon rims from 6,800-9,000 feet. Blooms in late June through July.	Yes	No

In addition, recently discovered areas on the Ashland District have *Lomatium nuttallii* and areas on the Beartooth District have populations of *Ranunculus jovis.* . Although these species are not currently on the Custer National Forest Sensitive Plant list, they are listed as species of concern in Montana according to the Montana Heritage Program (http://nhp.nris.state.mt.us/plants/index.html). The *Lomatium* site does not have weeds adjacent to its location. The *Ranunculus* sites have historically known leafy spurge and knapweed sites nearby.

At least one species is particularly vulnerable to weed infestations and weed management activities. Roadside low density infestations of spotted knapweed, dalmatian toadflax, and houndstongue are found adjacent to three Beartooth goldenweed populations on the Beartooth District. These situations currently occur in Sage Creek, Robertson Draw, and Seeley Creek.

Not only is Beartooth goldenweed vulnerable to weed competition and herbicide use, the level of risk on the viability of the population is increased because it is considered an endemic only recorded in 8 locations in Carbon County, MT and 14 locations in Park County, WY. Given its vulnerability and current proximity to known weed infestations, priority should be given to weed treatment efforts to prevent spotted knapweed or other weeds from out-competing Beartooth goldenweed.

Both the risk from weed infestation and the method of controlling the weeds can impact the sensitive plants. Some weed species and sensitive plant species are in the same plant family and therefore, herbicides that are specific to a plant family can affect both species (i.e. spotted knapweed and Beartooth goldenweed are both in the composite family). However, implementing protection measures outlined in Chapter 2 will minimize drift in these situations (i.e., no broadcast or aerial spraying within specific distances, sensitive species identification training of weed treatment crews, spot treat and/or wick treat weed species).

Also, to help protect sensitive species, periodically inspect known populations for the presence of invasive weeds. Treatment efforts are more effective and less disruptive when only treating a few weeds. If spotted knapweed or other invasive weeds become well established, then the herbicide broadcast treatment may be detrimental to sensitive plants, leaving backpack spot treatment or possibly only individual wicking applications and hand-pulling as options.

WILDLIFE

Wildlife - Regulatory Framework

Regulations on wildlife resources are outlined in 36 CFR 219.12 and 219.27. These regulations state that management indicator species (MIS) will be identified by each national forest in order to adequately maintain distributed habitat for these species and to evaluate the impacts of management activities on these species. Forest Service Manual 2670.31 (6) directs "identify and prescribe measures to prevent adverse modification or destruction of critical habitat and other habitats essential for the conservation of endangered, threatened, and proposed species."

Forest Service Manual 2670 at 2670.22 – Sensitive Species, provides the following direction for sensitive wildlife:

- Develop and implement management practices to ensure that species do not become threatened or endangered because of Forest Service actions;
- Maintain viable populations of all native and desired nonnative wildlife, fish, and plant species in habitats distributed throughout their geographic range on national forest system lands;
- Develop and implement management objectives for populations and/or habitat of sensitive species.

The Endangered Species Act requires the conservation of threatened and endangered species, and prohibits carrying out or authorizing any action that may jeopardize a listed species or its critical habitat.

The National Forest Management Act provides for balanced consideration of all resources. It requires the Forest Service to plan for diversity of plant and animal communities. Under its regulations, the Forest Service is to maintain viable populations of existing and desired species, and to maintain and improve habitat of management indicator species.

The Custer National Forest Plan provides management direction, objectives and standards for management of wildlife species and habitats on the Forest. The Forest Plan also identifies Habitat Indicator Species which are more commonly known as Management Indicator Species.

Wildlife - Affected Area

The analysis area for wildlife includes species-specific habitats in proximity to proposed treatment areas, areas with identified noxious infestations. These habitats have the potential to be directly or indirectly impacted by herbicide application and disturbances associated with the proposed weed treatment methods.

Wildlife - Analysis Method

Published reports in scientific journals were reviewed along with file data from the Custer National Forest, unpublished reports, and personal communications. A Biological Evaluation and Biological Assessment are located in the project file.

Information on ecology, distribution, and habitat affinities for sensitive species was also obtained from the Montana Natural Heritage Database on the internet at http://nris.state.mt.us/animal/index.html.

Species known to occur on the Forest and species with the potential to occur are identified and discussed. Potential impacts were assessed based on animal habitat affinities and probability that a given habitat would be treated with herbicide to control noxious weed communities.

Wildlife - Affected Environment

The wildlife issue is grouped into four main categories: Threatened and Endangered Species; Sensitive Species; Management Indictor Species/Key Species and Herbicide Toxicity to Terrestrial Mammals and Birds.

THREATENED AND ENDANGERED SPECIES

Grizzly Bear

The grizzly bear was once found throughout much of the lower 48 states west of the Mississippi River. Currently, their distribution is restricted to five discreet populations: the Greater Yellowstone Ecosystem in portions of Montana, Wyoming, and Idaho; the Northern Continental Divide Ecosystem in Montana; the Cabinet-Yaak area in Montana and Idaho; the Selkirk Mountains in Idaho and Washington; and the North Cascades in Washington (USFWS 1993). The Custer National Forest provides secondary habitat for

grizzly bears in the Yellowstone Ecosystem. The Greater Yellowstone Ecosystem grizzly bear population has increased in size and distribution over the past decade, and has now met all recovery criteria (IGBC, 2003). They have expanded their range on the Forest over the past decade, and most of the available habitat on the Forest within the Beartooth Mountains has the potential for Grizzly bear occupation (Schwartz *et al.,* 2002).

Grizzly bears are large omnivores that typically utilize a wide variety of foods. Vegetation such as roots, tubers, bulbs, berries, nuts, and green herbaceous plants are seasonally important to grizzly bears. Additionally, high calorie animal food sources such as ungulates, ground squirrels, carrion, fish, and insects are highly valuable to them when they can be obtained (Robbins *et al*, 2004). To utilize such a wide variety of foods, bears use a wide variety of vegetation types spread out over large distances. These vegetation types include lower elevation sagebrush/grasslands or Douglas-fir stands as well as higher-elevation whitebark pine, lodgepole pine, and Engelmann spruce/subalpine fir.

Because maintaining secure areas with low levels of human disturbance is a key component of grizzly bear habitat management, the Custer Forest Plan adopted guidance from the Interagency Grizzly Bear Committee Taskforce Report (IGBC, 1986). The Forest supports approximately 5500 acres of MS I habitat and 105,000 of MS II habitat. All but 1300 acres of MS II habitat occur within the Absaroka-Beartooth Wilderness Area. The Final Conservation Strategy for the Grizzly Bear in the Yellowstone Ecosystem (IGBC, 2003) provides standards for road density and motorized access within the recovery zone. These standards require that there be no decrease in core areas within each Bear Management Subunit. Core areas are at least 0.3 miles from any open road or trail, where no motorized or high-intensity non-motorized use is allowed during the non-denning period. The Final Conservation Strategy also provides additional direction for access management, and specifies that reoccurring low-level helicopter flights should not be allowed within 500 meters of core habitat (IGBC, 2003). The Custer National Forest has adopted the standards and guidelines outlined by the Final Conservation Strategy for the Grizzly Bear in the Yellowstone Ecosystem (IGBC, 2003).

The use of sheep or goat grazing as a weed management tool has the potential to cause conflicts with grizzly bears. Grizzly bear depredations on domestic sheep and goat have long been a source of conflict between humans and bears. Custer National Forest livestock grazing permits and the Final Conservation Strategy for the Grizzly Bear in the Yellowstone Ecosystem (IGBC, 2003) contain standards addressing this fact. As a condition of grazing permits appropriate measures are required for removal or destruction of livestock carcasses to avoid habituation of grizzlies to livestock as food. The standards from the Conservation Strategy are: 1) no new active commercial livestock grazing allotments will be created inside the primary recovery area; and 2) there will be no increases in permitted sheep animal months inside the primary recovery area from the identified 1998 baseline.

Gray Wolf

Wolves were reintroduced to the Yellowstone area in 1995. The Forest Service is a full partner in implementing the conservation measures outlined in the Federal Register final rule, November 22, 1994. Wolves reintroduced to Yellowstone National Park (YNP) and the Greater Yellowstone Area (GYA), have been designated as a non-essential experimental population in accordance with Section 10 of the Endangered Species Act. The gray wolf historically occupied the Custer National Forest, and the Forest is within the Greater Yellowstone Gray Wolf Recovery Area. As of December 2004, there were an estimated 324 wolves in this area (USFWS *et al.*, 2004). There are approximately 17 packs within the GYA, but only 3 packs' territories are entirely or partially within the Forest. One pack maybe denning on the Forest (J. Trapp, MT Fish, Wildlife & Parks, personnel communication on 4/1/05).

In the Yellowstone area, wolves feed on elk, deer, moose, bison, and other ungulates, but elk are their primary prey (USFWS *et al.*, 2004). Wolves also preyed on livestock (USFWS *et al.*, 2003). Wolves follow big game movements and may concentrate on elk winter ranges, elk calving areas, and elk feeding areas (refuges) (USFWS *et al.*, 2002). Pups are whelped in a den during the spring (Mech, 1970), and moved to a rendezvous site several months later when they are able to leave the den until they are mobile enough to travel with the pack (Mech 1970).

Wolf territories are variable and may range from 60 to 900 square miles in size. Wolf packs recently reintroduced into YNP initially ranged over an area of 650 square miles (Fritts *et al.* 1997). Wolves may occupy a variety of habitats including grasslands, sagebrush steppes, coniferous and mixed forests, and alpine areas. Wolf distribution and habitat use is more closely tied to availability of food (especially ungulate prey) and denning areas than to vegetation cover type. Because of this tie with ungulate distribution, there would be overlap between wolf habitat and areas infested with weeds.

Canada Lynx

Optimal lynx habitat can generally be described as a mosaic of early-successional forest stands for foraging and late-successional forests with deadfall for security cover and denning habitat (Ruggiero *et al.*, 1994). Lynx inhabit the mid to high elevations where snow excludes most other predators during winter. Denning habitat occurs most often in subalpine fir forests where there is a high amount of down material (Ruggiero *et al.*, 1994). Snowshoe hares are the primary prey for lynx. Primary forest types that support snowshoe hare are subalpine fir, Engelmann spruce, Douglas-fir and lodgepole pine. The key component of snowshoe hare habitat is dense understory vegetation. In winter, lynx forage for hares in vegetation that provides a high density of young conifer stems or branches that protrude above the snow (Ruediger *et al.*, 2000). Snowshoe hares appear to avoid clear-cuts and very young stands (Ruediger *et al.*, 2000).

Lynx habitat and weed infestations generally do not overlap, because lynx are typically found in dense forested stands in which weeds are not able to compete with native vegetation. Approximately 2,500 gross acres of managed weed areas on the Forest are located within mapped lynx foraging and/or denning habitats. These weeds infestations are generally found in old cutting units that have not yet regenerated enough for weeds to be shaded out and are currently unsuitable lynx habitat or are located along narrow riparian stringers that offer limited lynx habitat. The exception is orange hawkweed, which can invade closed-canopy forests and is currently known to occur on a couple of sites on the Forest. Because its distribution is so limited, it does not occur on lynx habitat and treatments of orange hawkweed are not expected to occur within the next 10-15 years on a scale that could affect lynx or their habitat. Therefore, lynx will not be discussed further in this report.

Black-Footed Ferret

Black-footed ferrets are members of the weasel family (Mustelidae) and inhabit grassland habitats. Black-footed ferrets are long, slender-bodied animals (two feet long and weighing 2.5 pounds) similar in size to the mink. Their physical characteristics include: a brownish-black mask across the face, a brownish head, black feet and legs, and a black tip on the tail. Ventral hair is lighter than dorsal hair. The middle of the back has brown-tipped guard hairs, which create the appearance of a dark saddle (USFWS 2000).

Black-footed ferrets have one litter with four to five young per year. The young do not come above ground until six weeks old. Mothers and young stay together until mid-August. At that time, females begin to separate siblings into different burrows. From August through early September, young ferrets become increasingly solitary. By early October they are self-sufficient (USFWS 2000).

Typical black-footed ferret behavior revolves around prairie dog towns. Ferrets are obligate associates of prairie dogs, which they prey upon. Research from ferret-occupied prairie dog colonies indicates that the most important attribute of ferret habitat is the distribution and abundance of prairie dogs. To support a viable population of ferrets, a prairie dog colony complex of 2,500-3,000 ha (6,200-7,400 acres) composed of individual colonies at least 12 ha (30 acres) in size, with the majority 50 ha (125 acres) or larger, is needed (Forrest et al., 1985).

The current distribution of prairie dogs on the Custer National Forest is approximately 1000 acres. Currently about 100 acres of white-tailed prairie dogs occupy the Beatooth RD, 100 acres of black-tailed prairies on the Sioux Rd and 800 acres of black-tailed prairie dogs on the Ashland RD. None of the active towns would meet the criteria for a prairie dog colony complex because of size or distribution. Most of the NFS land within the Forest boundary is unsuitable habitat for prairie dogs because of steep slopes, shallow soil over bedrock, or forest cover. There is insufficient suitable habitat to support back-footed ferrets on or immediately adjacent to NFS lands. Therefore, black-footed ferrets will not be discussed further in this report.

Bald Eagle

The Forest provides some yearlong habitat for bald eagles but primarily provides wintering habitat. In Montana, bald eagle nest sites are generally distributed around the periphery of lakes and reservoirs greater than 80 acres (32.4 ha) as well as in forested corridors within one mile (1.6 km) of major rivers (MT Bald Eagle Working Group, 1994). Currently the Custer National Forest does not have any known active nest sites. An historic nest site was thought to occur near Mystic Lake on the Beartooth RD but has not been active for at least the past two years. In Montana, an annual breeding cycle from initiation of courtship and nest building through fledging of young occurs approximately from February 1-August 15 (MT Bald Eagle Working Group, 1994). Once fledged, young are dependent on adults for six to ten weeks (MT Bald Eagle Working Group, 1994).

Adults may migrate or remain within their ecosystems during the winter. Wintering bald eagles occupy areas near unfrozen portions of lakes and free flowing rivers, or upland areas where ungulate carrion and lagomorphs are available (MT Bald Eagle Working Group, 1994). Bald eagles primarily winter in open water areas along the Yellowstone River and Clarks Fork of the Yellowstone River.

An available prey base may be the most important factor determining the nesting habitat suitability, the nesting density and the productivity (MT Bald Eagle Working Group, 1994) of bald eagles. Bald eagles are opportunist feeders and will prey on fishes, waterfowl, lagomorphs, and some ground dwelling mammals, as well as ungulate carrion. Ungulate carrion and waterfowl may also provide seasonal food sources (Stangl, 1994).

Bald eagles may be affected by a variety of human activities (MT Bald Eagle Working Group, 1994). Responses of eagles may range from abandonment of nest sites to temporary temporal and spatial avoidance of human activities. Responses may also vary depending on type, intensity, duration, timing, predictability and location of human activities. Individual pairs may respond differently to human disturbances because some birds are more tolerant than others (MT Bald Eagle Working Group, 1994). Generally, eagles are most sensitive to human activities during nest building, egg-laying, and incubation from February 1-May 30 (MT Bald Eagle Working Group, 1994). Human activities during this time may cause nest abandonment and reproductive failure. Once young have hatched, a breeding pair is less likely to abandon the nest. However, eagles may leave the nest due to prolonged disturbances, exposing young to predation and adverse weather conditions (MT Bald Eagle Working Group, 1994). Weed treatment activities have the potential to cause disturbance to nesting bald eagles if they occurred within nesting territories.

The Custer Forest Plan (USFS, 1986) outlines specific management direction for nesting bald eagles. The FP guidelines were derived from the Greater Yellowstone Bald Eagle Management Plan (Greater Yellowstone Bald Eagle Working Group 1996). This document provides guidelines for managing human activities around bald eagle nest sites (Greater Yellowstone Bald Eagle Working Group, 1996). The plan states that human activities should not exceed minimal levels (no human activity except for existing agricultural uses, nesting surveys, or river boat traffic during less than 70 percent of daylight hours) within the occupied nesting area or zone I (less than 400 meter from a nest) of eagle nests from February 15-July 15. Within the primary use area or zone II (less than 800 meter from a nest), no more than light human activity levels (day use and low impact activities at low densities and frequencies) should be allowed during the same time period. Moderate activity (low impact activities at any intensities) would be allowed within the home range or zone III (<4 km of a nest). Since the Forest currently does not have any active nest sites and protection measures are in place in the FP should a nest occur on NFS lands, bald eagles will not be discussed further in this report.

SENSITIVE WILDLIFE SPECIES

Sensitive species are those animal species identified by the Regional Forester for which population viability is a concern as evidenced by a significant downward trend in population numbers, density, or in habitat capability that will reduce a species' existing distribution (FSM 2670.5.19). There are 18 terrestrial wildlife species listed as sensitive for the Northern Region National Forests including the Custer, and which are discussed in this section. Sensitive fish, amphibians and reptiles are addressed in the Fisheries/Amphibians section. Sensitive plants are addressed in the Vegetation section.

Protection of sensitive species and their habitats is a response to the mandate of the National Forest Management Act (NFMA) to maintain viable populations of all native and desired non-native vertebrate species (36 CFR 219.19). The sensitive species program is intended to be proactive by identifying potentially vulnerable species and taking positive action to prevent declines that will result in listing under the Endangered Species Act.

As part of the National Environmental Policy Act (NEPA) decision-making process, proposed Forest Service programs or activities are to be reviewed to determine how an action will affect sensitive species (FSM 2670.32). The goal of the analysis should be to avoid or minimize impacts to sensitive species. If impacts cannot be avoided, the degree of potential adverse effects on the population or its habitat within the project area needs to be assessed.

American Peregrine Falcon

Peregrines occupy a variety of habitat but are typically found near water because of the abundance of prey associated with such sites. Nests are generally located below 8500 feet in elevation, less than 3,000 feet from water or a wetland, on a greater than 150 percent slope, and on a cliff ledge that is 3,000 feet in length and greater than 4,000 feet in height. Prey consists almost entirely of birds, which are usually taken on the wing. Surveys of potential peregrine falcon nesting habitat are completed on the Forest each year to monitor known nest sites and document new breeding pairs. One known active eyrie (hack site) is located on the Beartooth Ranger District. This nest site has been active every year since 1997. This nest site is located approximately ¾ of a mile from the nearest known noxious weed infestation along East Rosebud Creek.

It appears that peregrine falcons are sensitive to human activities, especially those occurring above the nest site. They are more tolerant of activities that occur below the nest site if there is pronounced relief from the valley floor to the nest site (U.S. Fish and Wildlife Service, 1984). Human disturbance at the nest may lead to abandonment and interference with care of the chicks. Guidelines for minimizing disturbance to nesting peregrine falcons are to restrict human activities and disturbances in excess of what historically occurred during the nesting season within one mile of nest cliffs (U.S. Fish and Wildlife Service, 1984). Human activity along East Rosebud Creek is high since the road is paved and many recreation residences occur in the area. The use of pesticides that persist in the environment and magnify through the food chain also presents a risk to peregrines (U.S. Fish and Wildlife Service, 1984). Because peregrines may forage in a variety of habitats, some areas used by these birds for foraging may be at risk of weed infestation while others would not be. Since the falcons occupying this site are acclimated to the level of human disturbance occurring in the area and the protection measures for herbicide use near aquatic habitats, peregrine falcons will not be discussed further in this report.

Northern goshawk

The goshawk is a large forest-dwelling hawk. Their prey may include grouse, smaller birds such as jays and woodpeckers, snowshoe hares, and squirrels (Reynolds *et al.*, 1992). Reynolds et al. (1992) identified the three components of a goshawk nesting home range as being the nest area, post-fledging family area (PFA), and foraging area. Nest areas are composed of older-aged forests with a closed canopy and larger diameter trees located on northern aspects with gentle to moderately steep slopes below 7500 feet in elevation (Reynolds *et al.*, 1992). PFAs contain a large percentage of mature forest habitats. Closed crowns forming a matrix enable young fledged birds to branch from one tree to the next and move throughout the forest canopy. Foraging areas are increasingly larger and more diverse than either the habitat maintained for nesting or the PFA. A diverse complex of vegetation within the foraging area supports a varied and abundant preybase. Foraging habitat in Montana includes forest edges, open meadows, and moderate to densely forested stands (Hayward *et al.*, 1990). Goshawks are known to occur on the Forest and suitable goshawk habitat is found on all districts, but the number of nesting goshawks is unknown. Goshawk foraging areas may include areas at risk of weed infestations, but nesting and PFAs would generally not because the level of canopy closure would be limiting.

Black-Backed Woodpecker

Black-backed woodpecker inhabits mature to over-mature coniferous forests across North America. It is rare throughout its range, but may be locally common in response to a temporary abundance of food. Black-backed woodpeckers respond opportunistically to insect outbreaks and seem to prefer recently burned stands, where they forage on insects. Populations of the black-backed woodpecker tend to be irruptive in nature and correspond with the sporadic abundance of bark beetles, its preferred prey. The woodpecker shows a preference for mature pine stands at elevations at or below 5200 feet (O'Conner and Hillis, 2001). Black-backed woodpeckers will use higher elevation areas once a fire or other disturbance occurs which brings in snags and insects (O'Conner and Hillis, 2001). Burned areas inhabited by this species may be at high risk for weed infestation. However, they are dependant on forest structure rather than ground vegetation, and would not be affected by project activities. Therefore, they will not be discussed further in this report.

Baird's Sparrow

Baird's sparrow nests on the ground in extensive, idle, or lightly grazed mixed-grass prairie with or without scattered low shrubs (Green et al. 2002). Because a relatively complex structure is so important for nesting, areas with little to no grazing activity are required (MTNHP 2005). Therefore habitat suitability would be mostly regulated by the livestock grazing intensities. Suitable habitat for the Baird's sparrow may be found on the Ashland and Sioux Ranger Districts where occupation would be limited by the availability of lightly grazed or ungrazed mixed-grass prairie. Rested or lightly grazed patches of native grasslands tend to occur in relatively small patches at scattered locations and the patterns of grazing shift from year to year within the grazing allotments. On the average, any areas lightly grazed areas on gentle terrain would generally be located at least 0.5 miles from water sources available to livestock. To date, three Baird's sparrows have been identified with the Forests landbird monitoring program in 2002. Landbird data has been recorded forest-wide in 2002 thru 2004. Potential nesting and foraging habitats may be at risk for weed infestation.

Blue-gray gnatcatcher

Blue-gray gnatcatcher breeding habitat in Montana seems to be restricted to open juniper and limber pine stands with intermixed big sage. Nests were found in juniper or big sage located on lower slopes or canyon bottoms (MTNHP 2005). Range-wide they typically inhabit a broad range of broad-leaved wooded habitats from shrublands to mature forest. They are rarely found in habitats dominated by needle-leaved conifers (Ellison 1992). Blue-gray gnatcatchers feed on adult insects and their larva and eggs as well as spiders (MTNHP 2005). They forage by gleaning food from outer foliage and occasionally along branches and trunks (Ellison 1992). They also dart out from perches to catch insects from the air MTNHP 2005). To date, blue-gray gnatcatchers have been verified in the Pryor Mountains with the Forests landbird monitoring program. Landbird data has been recorded forest-wide in 2002 thru 2004. Potential nesting and foraging habitats may be at risk for weed infestation.

Burrowing Owl

Burrowing owls are found in open grassland habitat where they nest and roost in abandoned animal burrows. They typically perch on the lip of their prairie burrows but have been observed perched on fence posts (MTNHP 2005). Black-tailed prairie dog and Richardson's ground squirrel provide the primary and secondary habitat for burrowing owls in Montana (Klute et al. 2003). They are opportunistic feeders with a varied diet that changes with the season of the year. Invertebrates comprise the bulk of their diet but small mammals, amphibians, reptiles, and birds may be taken (Haug et al, 1993). Recreational shooting of prairie dogs has the high potential for direct illegal mortality to burrowing owls (Haug et al, 1993). An historic burrowing owl record was documented on the Forest in 1989 on the Ashland RD. This sighting was associated with a black-tailed prairie dog town. No burrowing owl sightings during the breeding season have been recorded on the Forest during the past three years with the Landbird inventory program. All of the Forest prairie dog colonies have been inventoried and mapped over the past five years and no burrowing owl sightings have been documented. Since burrowing owls are highly associated with prairie dog colonies in eastern Montana, the effects of noxious weed infestations and treatments should be

the same for both animal species. Therefore no further discussion on burrowing owls will be documented in this report. Refer to habitat effects discussion for black-tailed prairie dogs.

Greater Sage Grouse

The sage grouse is North America's largest grouse. They are closely associated with sagebrush ecosystems. Since sagebrush ecosystems have a large amount of natural variation in vegetative composition, fragmentation, topography, weather, and fire regimes, sage grouse are adapted to a wide array of sagebrush conditions throughout their habitat (Schroeder et al. 1999). Sage grouse live year-round in portions of Montana east of the Continental Divide (Lenard et al. 2003). Sage grouse diets vary with the season but big sagebrush, succulent forbs, and invertebrates are important dietary components (Connelly et al. 2000). Sage grouse rely on the availability of breeding habitat, nesting habitat, brood-rearing habitat and wintering habitat. Breeding habitat typically consists of strutting grounds (leks) which are flat openings surrounded by sagebrush with a 20 to 50 % canopy closure (cc). Sage grouse prefer sagebrush (15-30%cc) with residual grass for nesting cover. Brood-rearing habitat can be highly variable but usually consists of areas with an abundance of succulent forbs and sagebrush with 8 to 14 % canopy closure. Sage grouse generally select areas with tall and large expanses of dense sagebrush for winter habitat (MTSGWG 2005). Currently about 4,850 gross acres of managed weed areas fall within sagebrush habitats on the Forest. Potential sage grouse brood rearing habitat and wintering habitat may be at risk for weed infestation.

Harlequin Duck

Harlequin duck population winters along the north Pacific Coast, and migrates inland to breed east to the Rocky Mountains. In Montana, they inhabit fast moving, moderate to high gradient, clear mountain streams during the breeding season (MTNHP 2005). Both females and males usually return to the same breeding sites each year (Carlson 2004). The harlequin duck is known to nest in the Beartooth Mountains on the Beartooth RD. Harlequins feed primarily on aquatic invertebrates (MTNHP 2005). Historically harlequins were documented to nest on the West Fork and Lake Fork of Rock Creek. Recent occupation has not been documented in the past three survey seasons. There is little overlap between harlequin duck habitat and areas at risk of weed infestation. Therefore, they would not be affected by this project and will not be discussed further in this report.

Loggerhead shrike

Loggerhead shrikes breed throughout the eastern two-thirds of Montana. They nest in thickets of small trees and shrubs (sagebrush or woody draws) or shelterbelts adjacent to native grassland or cropland (MTNHP 2005). The diet of the loggerhead shrike consists primarily of insects in the summer and mice in the winter. Habitat loss, sagebrush and woody draws, due to agricultural conversion is a major reason for the decline. Shrikes are susceptible to automobiles because of their habitat of feeding on grasshoppers and other insects (Rauscher 1999). Based on 2002-2004 Landbird data, loggerhead shrikes are present throughout the Forest especially on the Ashland and Sioux RDs. The intermingled patches of sagebrush and woody draw habitats with grasslands offer breeding and foraging habitat. These habitats may be at risk for weed infestations.

Long-Billed Curlew

Long-billed curlews are the largest North American shorebird. They are endemic to the Great Plains and breed in short-grass and mixed-grass habitats in eastern Montana (Dugger and Dugger 2002). They select for flat to rolling topography with short, open or sparse grassland where areas with dense, tall vegetation are generally avoided (Dugger and Dugger 2002). Within their breeding habitat, they feed on terrestrial insects. On the Custer National Forest suitable habitat for curlews would primarily be located on moderately to highly grazed livestock grazing allotments or on black-tailed prairie dog towns. Suitable habitats as a result of livestock grazing are susceptible to weed infestations. Habitats associated with prairie dogs towns seem to be less susceptible to weed infestations.

Long-Eared Myotis

Long-eared myotis are thought to be widespread and found throughout Montana (MTNHP 2005). They are found in a variety of habitats but are strongly associated with coniferous forests (Worthington 1991). They feed between treetops and over woodland ponds by gleaning form vegetation and taking aerial prey using echolocation (Worthington 1991). Primary roosting habitat is normally large diameter snags with intermediate stages of decay with exfoliating bark or cavities (MTNHP 2005). Secondary roost sites include mines, caves, sinkholes, cliff fissures, and abandoned buildings (Schmidt 2003). Optimum roost habitat is located within 0.5-1km of open water for foraging and drinking (MTNHP 2005). They use caves or mines for hibernacula. Long-eared myotis foraging habitat could include areas at risk of weed infestation.

Long-Legged Myotis

Long-legged myotis are thought to be widespread and found throughout Montana (MTNHP 2005). Primarily a coniferous-juniper forest bat found at moderate elevations (≥6000 ft) but may also inhabit riparian cottonwood bottoms and desert areas (Foresman 2001). They feed on insects using fast, direct flight along forest edges or in or above the forest canopy (Fenton and Bell 1979). Long-legged myotis use trees/snags (under bark or in cavities), caves, mines and rock crevices for roost sites (Tigner and Stukel 2003). They use caves or mines for hibernacula. Long-eared myotis foraging habitat could include areas at risk of weed infestation.

Pallid Bat

The Pallid bat occurs in arid and semi-arid habitats in the western United States and central Mexico. In Montana, this species has only been recorded in the Pryor Mountains adjacent to the Custer NF. Pallid bats inhabit areas with rocky outcrops dominated by desert shrubs, dry forest communities such as riparian forest along lakes and streams, and dry forest dominated by ponderosa pine. The Pryor Mountain sites were dominated by juniper and black sagebrush (Worthington 1991). Daytime roosts are predominately in rock cavities and buildings, whereas night roosting occurs in open shelters such as bridges, and cave or mine openings (Genter and Jurist 1995). Habitat use in Montana by this species remains poorly unknown and unstudied (MTNHP 2005). Pallid bats forage close to or on the ground for prey such as grasshoppers, crickets, mice and lizards (Hermanson and O'Shea, 1983). Pallid bat foraging habitat could include areas at risk of weed infestation.

Spotted Bat

Spotted bats occur in open ponderosa pine, sagebrush, rabbitbrush, and juniper as well as in deserts and other arid terrain (Watkins 1977). They are invariably found in remote, undisturbed settings such as the numerous caves and rock crevices found in the Pryor Mountains (MTNHP 2005). Day roosting typically occurs in fractured sedimentary cliffs, and openings in drier ponderosa pine forests provide foraging habitat. Spotted bats are territorial and space themselves along regular foraging routes in suitable habitat (Woodsworth et al. 1981). Specific foraging habitat requirements are not well understood, but previous studies have shown that spotted bats feed almost exclusively on moths. Suitable spotted bat roosting and foraging habitat occurs on the Custer National Forest portion of the Pryor Mountains. Spotted bats are thought to be highly sensitive to human disturbance, the disturbance or destruction of roosting habitat is the greatest threat to the species. Spotted bat foraging habitat could include areas at risk of weed infestation.

Townsend's Big-Eared Bat

Townsend's big-eared bats inhabit high-elevation conifer forests, pinyon-juniper woodlands, and desert shrublands, and ranges throughout western North America south to central Mexico. Habitat use in Montana has not been evaluated in detail but seems to be similar to other locations in the western United States (MTNHP 2005). They roost in caves, mines, crevices on rocky cliffs, or in buildings. Males and females roost separately during summer, when males roost singly and females gather in nursery colonies located in caves or mines (Worthington 1991). Both males and females move to caves and mine tunnels in winter to hibernate (Worthington 1991). Townsend's big-eared bats are dependent on underground structure year-round (SDGFP 2003). They forage over sagebrush-grasslands, riparian areas, open pine forests, and arid scrub, feeding mainly in the air along forest edges (Schmidt 2003). They are

insectivorous and feed primarily on moths (Schmidt 2003). Townsend's big-eared bats are thought to be highly sensitive to human disturbance during hibernation and temperature variation during hibernation. These disturbances are thought to be the greatest threats to the species. Townsend's big-eared bat foraging habitat could include areas at risk of weed infestation.

Black-tailed prairie dog

The black-tailed prairie dog (BTPD) is the largest of the five prairie dog species. The black-tailed prairie dog is the most widely distributed species in Montana. They occupy flat, open short and mixed-grass habitats and shrub/grassland habitats east on the Continental Divide in Montana (MTPDWG 2002). BTPD prefer to feed on grasses but their diet will shift to forbs with the seasons. Prairie dogs are semi-fossorial, digging burrows that provide protection from predators and weather. Black-tailed prairie dogs are the most colonial of the five prairie dog species and occur at the highest densities (MTPDWG 2002). Sylvatic plague, recreational shooting, poisoning, and habitat fragmentation are the primary threats to black-tailed prairie dogs (MTPDWG 2002).

The Forest Plan identifies a goal for the maximum acreage of primary suitable range occupied by prairie dogs for each Ranger District: 300 acres on Ashland, 50 acres on Sioux and 50 acres on Beartooth (USFS, 1986, p. 20). No limits are established for prairie dog acreage on secondary and unsuitable range. The USFS was a participant in the multi-party development of a Conservation Plan for black-tailed and white-tailed prairie dogs in Montana, which was recently approved (MTPDWG 2002). "The goal of this conservation plan for the state of Montana is to provide for management of prairie dog populations and habitats to ensure long-term viability of prairie dogs and associated species." In 2003, there were at least 680 acres in 55 active colonies of black-tailed prairie dog on NFS lands on the Ashland Ranger District and 16 acres in two active towns on the Sioux RD. All of the Forest prairie dog colonies have been inventoried and mapped over the past five. To date none of the 696 acres of active BTPD colonies have noxious weed infestations.

White-tailed prairie dog

The white-tailed prairie dog (WTPD) is a medium sized prairie dog species. The white-tailed prairie dog has a very limited distribution in south central Montana between the Pryor and Beartooth Mountains (MTPDWG 2002). They inhabit xeric sites with mixed stands of shrubs and grasses (MTNHP 2005). WTPD are much more tolerant of sloped topography and dense vegetation than BTPD. Their range in Montana is at higher elevations than other areas across their distribution, south central Montana is on the edge of their range (MTNHP 2005). White-tailed prairie dogs feed on sagebrush, with a shift to forbs when they become available (Foresman 2001). They are semi-fossorial, digging burrows that provide protection from predators and weather. White-tailed prairie dogs occur at low densities and are less colonial with more space in between mounds (MTPDWG 2002). Sylvatic plague, recreational shooting, poisoning, and habitat fragmentation are the primary threats to white-tailed prairie dogs (MTPDWG 2002).

The Forest Plan identifies a goal for the acceptable acreage of primary suitable range occupied by prairie dogs for each Ranger District: 300 acres on Ashland, 50 acres on Sioux and 50 acres on Beartooth (USFS, 1986, p. 20). No limits are established for prairie dog acreage on secondary and unsuitable range. The USFS was a participant in the multi-party development of a Conservation Plan for black-tailed and white-tailed prairie dogs in Montana, which was recently approved (MTPDWG 2002). "The goal of this conservation plan for the state of Montana is to provide for management of prairie dog populations and habitats to ensure long-term viability of prairie dogs and associated species." In 2002-4, there was an active 92 acre white-tailed prairie dog town on the Beartooth RD. As of 2004, this colony does not have noxious weed infestations.

Wolverine

Wolverines are the largest member of the weasel family. Although few studies have been conducted on them, they appear to utilize a wide variety of food sources including carrion, rodents, berries, insects, and birds (Reel *et al.*, 1989; Ruggiero et al. 1994). In the western United States they occupy a variety of mostly remote montane habitats throughout the year including alpine areas, boulder and talus fields, mature and intermediate forests adjacent to natural openings, big game winter ranges, and riparian areas

(Reel *et al.*, 1989; Ruggiero et al. 1994). Extensive travel by wolverines is not unusual and home ranges are typically very large (Ruggiero *et al.*, 1994). Although wolverine populations have increased in western Montana since the 1920's, they occur at low densities even where habitat is optimal (Ruggiero *et al.*, 1994). Suitable habitat for wolverines on the Forest is found in the Beartooth and Absaroka Mountain Ranges. Wolverines are known to occur on the Forest as on occasion observations of wolverines or their tracks are reported, but their distribution and abundance remains unclear. Most wolverine habitat would be at low risk of weed infestation, with the exception of big-game winter ranges.

MANAGEMENT INDICATOR SPECIES (MIS) AND KEY SPECIES

Management Indicator Species (MIS) are species whose habitat is most likely to be affected by forest management activities and serve as indicators of change for threatened or endangered species, big game species, or certain habitat types. There are ten terrestrial MIS for the Custer National Forest, one of which was discussed earlier in this section. There are eight Key Species for the Forest as identified in the Forest Plan. Key Species are defined as major interest species that are commonly hunted, fished, or have special or unique habitat needs (USFS Custer Forest Plan 1986). MIS and Key Species are shown in Table 3 – 17.

TABLE 3 - 17. TERRESTRIAL MANAGEMENT INDICATOR SPECIES AND KEY SPECIES

Species	Type of Habitat	Suitable Habitat on R.D.
MIS		
Northern Goshawk	Forest: old growth	All Districts
White-tailed Deer	Forest: dog hair ponderosa pine	All Districts
Ruffed grouse	Forest: aspen	Beartooth RD
Western kingbird	Forest: open savanna	All Districts
Bullock's (Northern) oriole	Riparian: tree	All Districts
Yellow warbler	Riparian: shrub	All Districts
Ovenbird	Hardwood draw: tree	Sioux RD, Ashland RD
Spotted (Rufous-sided) towhee	Hardwood draw: shrub	Sioux RD, Ashland RD
Brewer's sparrow	Evergreen shrubs: sagebrush	Sioux RD, Ashland RD
Sharp-tailed grouse	Prairie grasslands	Sioux RD, Ashland RD
Key Species		
Elk	Key (Major Interest)	All Districts
Golden eagle	Key (Major Interest)	All Districts
Merlin	Key (Major Interest)	All Districts
Mule deer	Key (Major Interest)	All Districts
White-tailed deer	Key (Major Interest)	All Districts
Bighorn sheep	Key (Major Interest)	Beartooth RD
Pronghorn antelope	Key (Major Interest)	Sioux RD, Ashland RD
Sharp-tailed grouse	Key (Major Interest)	Sioux RD, Ashland RD

The ecology of these Management Indicator Species and Key Species is representative of the diversity of terrestrial wildlife species found in grassland, sagebrush, ponderosa pine, riparian, hardwood draw and mixed forest habitats located across the Custer National Forest. At varying degrees, all of the listed MIS and key species are dependent on native vegetation to provide adequate nesting cover, forage, shelter or cover for prey. Northern goshawks, golden eagles, and merlins eat either mice, voles, or a variety of other small mammals, birds, and reptiles (MTNHP 2005).

Ruffed grouse, Western kingbirds, Bullock's orioles, yellow warblers, ovenbirds, spotted towhees, Brewer's sparrows, and sharp-tailed grouse either nest on the ground or within branches of trees and shrubs. They forage on insects, forbs, plant buds and plant seeds (MTNHP 2005).

Noxious weeds were listed as a threat for species inhabiting grasslands, sagebrush shrub steppe and riparian habitats (Casey 2000). White-tailed deer, elk and mule deer are highly adaptable species that annually use a wide variety of habitats including riparian areas, open grasslands as well as all forest types. Nearly the entire Forest provides habitat for these ungulates during some time of the year. They are capable of grazing or browsing a wide range of plants during different seasons, but in Montana browse plants such as sagebrush, chokecherry and snowberry are an important dietary component year-round but grasses or forbs may be used part of the year (MTNHP 2005).

Noxious weeds are typically not eaten by white-tailed deer, elk or mule deer at all, or are of very low palatability. Part of their seasonal habitats such as grasslands and riparian areas are at high risk for weed infestation. Infestations of weeds such as spotted knapweed can lead to 60-90 percent decreases in forage production on seasonal ranges (Rice *et al.*, 1997), which would potentially decrease the number of ungulates that seasonal ranges can support. White-tailed deer, elk and mule deer populations on the Forest are currently at or above objectives set by the Montana Department of Fish, Wildlife, and Parks (MDFWP). Pronghorn antelope occupy open, rolling sagebrush / grasslands (MTNHP 2005). They feed on forbs in the spring and summer and browse on primarily sagebrush during the winter (MTNHP 2005). Again noxious weeds are a threat to grassland/sagebrush habitats.

Bighorn sheep typically inhabit cliffs and high mountain slopes during the spring, summer and fall. Rolling foothills are used for winter habitat (MTNHP 2005). They feed on bunchgrasses and shrubs on winter range and a wide variety of grasses, sedges, and forbs on summer range (MTNHP 2005). Noxious weed infestation is generally not a threat to summer range but may be a problem on winter habitat.

WILDERNESS AND INVENTORIED ROADLESS AREAS

Wilderness Areas are areas of federally owned land that have been designated by Congress as Wilderness, in accordance with the Wilderness Act of 1964. These areas are protected and managed so as to preserve their natural conditions which (1) generally appear to have been affected primarily by forces of nature with the imprint of man's activity substantially unnoticeable; (2) have outstanding opportunities for solitude or a primitive and confined type of recreation; (3) have at least 5,000 acres or is of sufficient size to make practical their preservation, enjoyment, and use in an unimpaired condition; and (4) may contain features of scientific, educational, scenic, or historical value as well as ecologic and geologic interest.

Inventoried Roadless Areas (IRAs) have been identified in a set of inventoried roadless area maps, contained in the 1986 Custer National Forest Plan FEIS Appendices and September 15, 2000 Roadless Area Inventory.

Wilderness and Inventoried Roadless Areas - Regulatory Framework

Designated Wilderness is mandated to be administered so that its community of life is untrammeled by man, its primeval character retained and naturally functioning ecosystems preserved (PL 88-577).

Wilderness areas are managed as directed by the Wilderness Act of 1964. Management actions within Wilderness focus on maintaining naturally functioning ecosystems, providing access, and managing some pre-existing uses (i.e. outfitter operations). Examples of management activities include trail construction and maintenance, fire suppression or management of naturally ignited fires, removal of existing structures, and noxious weed treatment.

Forest Service Manual (FSM) 2323.26b allows plant control for "noxious farm weeds by grubbing or with chemicals when they threaten lands outside Wilderness or when they are spreading within the Wilderness, provided that it is possible to effect control without causing serious adverse impacts on Wilderness values. FSM 2109.14 (13.4) requires Regional Forester approval of a pesticide use proposal in designated Wilderness Areas.

Congress gives no specific direction as to management of noxious weeds in Forest Service recommended wilderness areas. The Custer Forest Plan direction is to manage these areas to maintain their presently existing Wilderness character including opportunities for solitude, a sense of remoteness, and a natural appearing environment.

General direction for Wilderness and recommended wilderness management is found in the Custer Forest Plan, pages 4, 67-71. Specific direction for the Absaroka Beartooth is found in Forest Plan Appendix II, pages 155-161. Specifically, Forest Plan direction relating to management of noxious weeds in the Wilderness states:

- *All feed packed into the Wilderness will either be certified weed free or processed feed.*
- *Visitors will be encouraged to remove burs and weed seeds from stock prior to entering the Wilderness. This will be accomplished through brochures and at trailheads.*
- *Develop a program of noxious weed control.*

Inventoried Roadless Lands: There is currently no specific congressional oversight of inventoried roadless lands. Weed treatments on inventoried roadless lands would not need special approval simply because of the area's roadless status.

Wilderness and Inventoried Roadless Areas - Affected Area

The analysis area for wilderness and inventoried roadless areas is the extent of the individual wilderness area and/or roadless area.

Wilderness and Inventoried Roadless Areas - Analysis Method

Geographic Information System (GIS) spatial data was used to determine the location of Wilderness Areas, Wilderness Study Areas and IRAs relative to the proposed activities in the action alternatives. Existing condition was determined through mapping of known weed infestations from the GIS weed database. Potential types of treatments within these areas were estimated.

Management activities (proposed, and past, present and reasonably foreseeable) were evaluated for their potential effects on the Wilderness attributes listed in the Forest Service Northern Region "Our Approach to Effects Analysis" for assessing the impacts on Wilderness and roadless characteristics. This method was used for designated Wilderness, Forest Service recommended wilderness, and Inventoried Roadless Areas. The attributes include: natural integrity, apparent naturalness, remoteness and solitude, management, and boundaries. Natural integrity is the extent to which long-term ecological processes are intact and operating. Apparent naturalness is a measure of how natural the environment appears. Impacts to natural integrity and apparent naturalness are measured by the presence and magnitude of human induced change to an area. Solitude is a personal subjective value defined as isolation from the sights, sounds and presence of others, and the developments of man. Management and boundaries will not be affected by proposed activities and will not be discussed further.

Wilderness and Inventoried Roadless Areas - Affected Environment

The Beartooth Ranger District of the Custer National Forest is largely comprised of designated Wilderness, Forest Service recommended wilderness, or IRAs. Of the Forest's approximate 1.2 million acres of public land, over 75 percent of the Forest is within designated Wilderness, WSA, or Inventoried Roadless Areas. See Table 3 - 18 for the breakdown of acres.

TABLE 3 - 18. LAND IN WILDERNESS AND ROADLESS DESIGNATION[25].

Total Forest Acres	Absaroka Beartooth Wilderness Acres	Recommended Wilderness Acres	Inventoried Roadless (excluding Wilderness and Recommended Wilderness) Acres	Total Acres of Wilderness, Recommended Wilderness, and Inventoried Roadless Areas
1,200,000	333,000	14,000	131,900	478,900 or 40% of total Custer NF Acreage

Absaroka Beartooth Wilderness: Congress designated the Absaroka-Beartooth (AB) Wilderness Area in 1978. It encompasses a total of 943,626 acres. Montana contains 920,343 acres, divided between the Gallatin and Custer National Forests. The Wyoming portion contains 23,283 acres (located on the Shoshone NF).

The Crow Indians called themselves Apsaalooke, hence the name of the mountain range that, along with Beartooth, characterizes this Wilderness. Active glaciers, sweeping tundra plateaus, deep canyons,

[25] Inventoried Roadless Areas, September 15, 2000.

sparkling streams, and hundreds of alpine lakes combine to make this one of the most outstanding Wilderness areas in America.

The Absarokas, unlike the Beartooths, have ample vegetative cover, including dense forests and broad mountain meadows crossed by meandering streams. Bighorn sheep and mountain goats roam about the mostly rugged country, along with elk, deer, moose, marmots, coyotes, black bears, wolves and members of a substantial grizzly population. The harsher Beartooths accommodate far fewer animals. Trout reside in many of the lakes and streams in both ranges.

The history of domestic livestock grazing in the Absaroka-Beartooth has played a role in noxious weed distribution throughout this area. At one time, over 300,000 domestic sheep grazed in the AB Wilderness Area. There are currently no active allotments in the Custer NF portion of the Absaroka-Beartooth Wilderness Area.

Prevention and education has long been an important tactic in preventing the spread of noxious weeds in the Absaroka-Beartooth. Since 1977, all commercial outfitters have been required to use only certified weed free feeds. Since the mid 1990's all users were required to use certified weed free feeds. Educating the public about the weed issue, and vulnerability of weeds in the Absaroka-Beartooth has been a priority for over a decade.

Wilderness managers have been inventorying and monitoring weed populations in the Absaroka-Beartooth for over 20 years. Hand control operations, grubbing, pulling have been used throughout the Wilderness. Limited chemical and biological controls have been applied in specific locations on the Gallatin portion of the AB Wilderness (e.g. East Dam Ck. Spotted Knapweed Control Project). Chemical control of weeds on the Custer NF portion of the AB Wilderness has not been implemented since it has not previously undergone National Environmental Policy Act analysis.

The following table represents the weed inventory (Custer portion only) in the Absaroka-Beartooth at the end of 2002.

Of the 330,000 acres of Custer portion of the A-B Wilderness Area, only 45 net acres of Canada thistle exist. This species invaded the Stillwater drainage after the 1988 Storm Creek fire. The remaining acreage of the Wilderness remains fairly weed-free. This is likely due to the reduced ability for seed transport into the wilderness area as motorized or mechanized traffic is not permitted. However, weeds are annually found and treated in the 18 Wilderness Area trailheads on the Beartooth District. The current requirement to use only weed seed free hay Forest-wide has and will help limit the introduction of invaders. Also, the geographic high elevation settings seem to lessen invader's abilities to establish in alpine/subalpine habitats.

There are many aggressive weed infestations peripheral to the Absaroka-Beartooth. These aggressive weeds have the potential to infest the Wilderness, and destroy naturally functioning ecosystems.

Recommended Wilderness: Forest Plan management area H outlines Forest Service recommended wilderness in the West Rosebud, Burnt Fork, Red Lodge Creek, North of Twin Lakes, and Lost Water Canyon areas of the Beartooth Ranger District.
Weed monitoring has been infrequent in these areas. Weed infestations are not known to occur in these areas.

Inventoried Roadless Lands: Approximately 131,900 acres of inventoried roadless areas are located on the Custer National Forest. The inventory was displayed in the Custer Forest Plan FEIS, Appendices (USDA, 1987) and more recently reflected in the September 15, 2000 Roadless Area Inventory. In the late 1990's the Clinton Administration completed a nationwide study of "roadless" lands on public land, and maps of record included in the final rule (USDA, 2001). The final rule acknowledges that this inventory may not be perfectly accurate, and likely included lands which no longer retained their roadless characteristics. Inventoried roadless lands are found in all the mountain ranges on the Custer National Forest, and are currently allocated a wide variety of Forest Plan Management Area designations from the most protection (recommended wilderness) to allocations focusing on timber or range management. A

wide variety of land uses occur within these areas, from grazing allotments and mineral development to dispersed recreation use of trails and non-trail areas.

Weed monitoring has been infrequent in these areas. Weed infestations are not known to occur in these areas.

WILD AND SCENIC RIVERS

Regulatory Framework – Wild and Scenic Rivers

The Wild and Scenic Rivers Act (16 US1271) and Interagency Guidelines provided in the Wild and Scenic Rivers Reference Guide (USDA and others, 1995) provide the general direction for management of these rivers. Additional goals, guidelines, and standards are found in the Custer Forest Plan, as amended by Amendment #2. Management activities will comply with the standards for Wild and Scenic Rivers from Chapter 8 of the Forest Service handbook 1909.12.

The analysis is based on the potential for the proposed weed treatment activities to impact the values inherent to rivers or streams on the Custer National Forest that are potentially eligible for protection under the Wild and Scenic Rivers Act.

Wild and Scenic Rivers - Affected Environment

The Wild and Scenic Rivers Act was enacted to preserve in a free-flowing condition rivers which possessed outstanding scenic, recreational, geologic, fish and wildlife, historic cultural or other similar values. Congress declared that is was important to manage certain rivers in their free flowing condition, and to manage them and their immediate environment to protect those qualities for the benefit and enjoyment of present and future generations. The presence of weeds along the river corridor can detract from the aesthetic and recreational opportunities. The eligible river segments are assigned a potential classification of wild, scenic, or recreational. Characteristics of these classifications are:

- Wild River areas -free of impoundments, generally accessible only by trail, shorelines primitive and the water unpolluted;
- Scenic River areas - free of impoundments, shorelines largely undeveloped but accessible in places by road;
- Recreational River areas –readily accessible by roads, some development and may have impoundment or diversion.

Portions of seven streams were identified as "eligible" for Wild and Scenic River designation in the Record of Decision and Amendment #2 of the Custer Forest Plan (USDA, 1987). No suitability studies have been completed or transmitted to Congress to date. They include:

TABLE 3 – 19. ELIGIBLE WILD AND SCENIC RIVER INFESTATIONS

River / Segment	Potential Classification	Miles	Outstanding / Remarkable Values	Approx. Weed Net Infested Acres
Crooked Creek – Lost Water Canyon	Wild	8	Cultural, Fisheries, Geologic, Scenic	5
East Rosebud Creek	Recreational and Wild	20	Geologic, Recreation, Scenic	5
West Rosebud	Wild	8	Geologic, Recreation, Scenic	5
Stillwater	Recreational and Wild	27	Fisheries, Recreation, Scenic	45
Rock Creek	Recreational and Wild	16	Geologic, Recreation	20
West Fk. Rock Cr.	Recreational and Wild	20	Fisheries, Recreation, Scenic	15
Lake Fork Rock Cr.	Recreational and Wild	10	Geologic, Scenic	5
Total		109		100

RESEARCH NATURAL AREAS

Research Natural Areas - Regulatory Framework

Reasearch Natural Areas (RNAs) are managed to maintain the undisturbed conditions and natural processes that characterize these areas. The Custer Forest Plan, as amended, identifies three RNAs for their representative and/or unique natural and ecological features. Current RNAs include the Poker Jim on the Ashland District, Lost Water Canyon; and Line Creek Plateua RNAs on the Beartooth District. Deer Draw on the Sioux District is considered a candidate RNA.

The Code of Federal Regulations (CFR) provides management direction as follows "Forest Planning shall provide for the establishment of RNAs" (36 CFR 219.25) and "[RNAs] will be retained in a virgin or unmodified condition except where measures are required to maintain a plant community which the area is intended to represent" (36 CFR 251.23). The Forest Service Manual (FSM) also provides guiding management direction for RNAs (FSM 4063) and SIAs (FSM 2372). In addition, the individual establishment records for each area serve as Forest Plan direction (as amended).

Applicable to invasive species management, FSM 4063.3.8, 9 directs activities to comply with the following standards: *8) Where pest management activities are prescribed, they shall be as specific as possible against target organisms and induce minimal impact to other components of the ecosystem, and 9) If practicable, remove exotic plant or animal life.* Further, FSM 4063.32 directs that "*If exotic plants or animals have been introduced into an established RNA, the Station Director and the Regional Forester shall exercise control measures that are in keeping with established management principles and standards to eradicate them, when practical.*"

Lastly, FSM 4063.34 [in part] "*Use only tried and reliable vegetation management techniques and then apply them only where the vegetative type would be lost without management. The criterion here is that management practices must provide a closer approximation of the naturally occurring vegetation and the natural processes governing the vegetation than would be possible without management. Unless the manager is certain that the management practice will meet this criterion, do nothing.* Responsibility for management of RNAs is shared between the National Forest System and the Forest Service Research Station. The Regional Forester, with concurrence of the Research Station Director, has the authority to establish RNAs and approve research and monitoring activities. FSM 4063.34 continues, "*The Station Director, with the concurrence of the Forest Supervisor, may authorize management practices that are necessary for noxious weed control or to preserve the vegetation for which the research natural area was created.*

Procedures permitted for control of noxious weeds and uses of herbicides are described in FSM 4063. *Generally, the broad application of herbicides within RNA/ SIA would not be allowed. Actions would be taken to prevent introduction of noxious weeds to RNAs..*" However, it does not preclude the use of herbicides as a control measure.

The establishment records for all of the RNAs also state "*Pest management and noxious weed control will be as specific as possible against target organisms and induce minimal impact to other components of the area… If invasive exotics are discovered within the RNA, measures will be taken to control or eradicate these populations.*" Relative to some RNAs within designated wilderness areas is the direction that "*Management of the RNA will be compatible with and consistent with Wilderness management direction.*"

Research Natural Areas - Analysis area

The analysis areas for RNAs are the RNAs and their surrounding area. The focus of the analysis will be those RNAs that currently have some level of weed infestation as identified in the Affected Environment Section.

Research Natural Areas - Analysis Method

Information for the Affected Environment came from the Establishment Records for the individual RNAs, and current GIS and weed inventory data. The analysis is based on the effect the proposed activities in each alternative would have on the establishing criteria for each RNA, and potential for affecting ecological integrity.

RECREATION

Recreation - Regulatory Framework

The goal of the Custer National Forest Plan (1997) relative to recreation is to provide a broad spectrum of recreation opportunities in a variety of Forest settings. The Forest Service Manual, FSM 2300, describes the Forest Service Authority, Objectives, Policy, and Responsibility for recreation management. Pertinent Federal Laws are the Forest Rangeland Renewable Resources Planning Act of 1974, as amended by the National Forest Management Act, and the Wilderness Act of 1964.

Recreation - Analysis Area

The analysis area for recreation analysis is confined to all developed and non-developed recreation sites on the Custer National Forest.

Recreation - Analysis Method

The source of information for the Affected Environment was the Forest Plan and its associated EIS. The analysis is based on the potential for proliferation of invasive weeds if left untreated and proposed weed treatment activities to impact recreational opportunities on the Custer National Forest.

Recreation - Affected Environment

The Custer National Forest provides a wide range of recreation experiences. At one end of the spectrum are primitive non-motorized opportunities in places like the Cook Mountain Riding and Hiking Area, and the Absaroka-Beartooth Wilderness Area. The other end of the spectrum includes more developed settings like Red Lodge Mountain Ski Area. Weeds can be found in any of the recreation settings on the Forest.

Invasive weeds can affect the recreation experience. Invading weeds such as spotted knapweed, thistles, toadflax, leafy spurge, houndstongue, and oxeye daisy detract from the desirability of using recreation sites and enjoyment of the forest environment. These species diminish the usefulness of sites because the stiff plant stalks, thorns, or toxic sap can discourage or prevent walking, sitting, or setting up a camp. Invasive weeds also detract from the recreation experiences by reducing the variety and abundance of native flora to observe or study and reducing forage availability for wildlife and recreational livestock.

Weeds are frequently spread through recreational activities, particularly along roads, trails, campgrounds, and dispersed recreation sites. The Custer National Forest provides a variety of recreational experiences including camping, hiking, hunting, fishing, mountain biking, snowmobiling, horseback riding, skiing, and driving for pleasure. On the Beartooth District, there are an estimated 63,000 visitors annually accessing 18 major trailheads between the Memorial and Labor Day season. Campgrounds receive steady use.

Passenger vehicle roads provide primary transportation routes into and through out the Forest. While these roads provide access for a variety of purposes (commercial, residential, administrative), the primary public benefit is generally for recreational purposes. Controlling weeds along roads and recreational sites will reduce the tendency for recreational activities to spread weeds into adjacent areas.

Recreational stock can also spread weed seeds. Most of the recreational stock use on the Beartooth District is in the Stillwater, West Fork Stillwater, and East Rosebud. There is currently a weed seed free feed order in place which requires that any feed brought into public lands in Montana and South Dakota must be certified as weed seed free.

Forest visitor response to presence of weeds also covers a wide range. To some forest visitors the presence of weeds has a minimal impact on their experiences. This seems to the case, most frequently, to visitors and users of the more developed recreation sites. There appears to be more concern expressed by the recreating public over the presence of weeds in less developed recreation opportunity classes with primitive non-motorized setting having the greatest sensitivity. For example, users in the

Absaroka Beartooth Wilderness area seem to feel that weeds detract from their experience and in general this group is supportive of weed control efforts and reports new weed populations when they are discovered. In summary, there does seem to be a growing concern among recreationists that weeds are a negative impact on their experiences.

The issue of effects of herbicides on human health is treated separately in this analysis. Please refer to the human health sections in Chapters 3 and 4 for more information.

HERITAGE

Heritage - Regulatory Framework

The National Historic Preservation Act of 1966 (NHPA) and the Forests Plan provide the primary requirements applicable to situations where proposed management activities could potentially affect heritage resources on the Forests. Other applicable requirements come from the Archaeological Resources Protection Act, American Indian Religious Freedom Act, Executive Orders (11593, 13175 and 13287), and other laws, regulations and policies. Under Section 106 of NHPA, the Forest Service is required to evaluate effects of proposed management activities to historic properties (archaeological sites and ethnographic resources including traditional cultural properties). The Forest must also follow Forest Plan standards and guidelines for protecting heritage resources and coordinating with Native American tribes.

This document analyzes proposed weed treatment activities in accordance with NEPA, and tiers to applicable Section 106 NHPA process requirements. Tribal consultation requirements are also addressed, as well as monitoring requirements. If adverse effects cannot be avoided, then the Forest would consult with the SHPO, the Advisory Council and interested parties and develop an appropriate mitigation plan.

Heritage - Analysis Area

The analysis area for the heritage resource analysis is confined to all archeological and ethnographic sites known to occur on the Custer National Forest.

Heritage - Analysis Method

The source of information for the Affected Environment includes archeological resource surveys that have been conducted and various ethnographic studies that have been performed in and adjacent to the Custer National Forest. The analysis is based on the potential for proliferation of invasive weeds if left untreated and proposed weed treatment activities that could impact heritage resources on the Custer National Forest.

Heritage - Affected Environment

Weed infestations have not had any known impact on historic, prehistoric, or traditional cultural properties on the CNF. Nor have past herbicide and biological weed control resulted in known effects on historic properties or traditional plant gathering sites. However, invasive plants can crowd out plants traditionally gathered for food, dress, or ceremonial purposes and can influence wildlife and fish habitat ecology. Invasive weeds have diminished populations of some plants traditionally used by local tribes.

The Custer National Forest consults with eight tribes who have expressed interest in the projects and management of the CNF and who have aboriginal ties to the lands the National Forest administers. These tribes include the Crow, Northern Cheyenne, Assiniboine, Shoshone, Arapahoe, Shoshone-Bannock, Three Affiliated, and the Great Sioux Nation. Many tribal members continue to gather plant materials for traditional or cultural purposes.

During tribal consultation for this project, relevant concerns arose about the potential impacts from weed control treatments, such as: (1) potential loss of plant species that have a traditional, religious, or other use, and (2) potential health risks to those who collect herbicide-treated plants.

Heritage resource sites that may be affected by weed treatment activities fall broadly into two categories: (1) archaeological, and (2) ethnographic resources (including traditional cultural properties). These resources are described in the following two sections.

Archaeological Resources

Archaeological resources are generally defined as the nonrenewable evidence of human occupation or activity (as indicated by sites, buildings, structures, artifacts, ruins, objects, works of art, petroglyphs/pictographs, architecture, or natural features) that were important in human history at the State, local, or national level. Archaeological resources consist of the material remains of human activities on the Forest, including prehistoric and historic sites. The Forests have a long history of human use. Site types are diverse across both forests and include, but are not limited to, small artifact scatters, quarry and other resource procurement sites, historic cabins, homesteads, and mines. Historic sites represent a wide variety of activities that include logging, mining, ranching, exploration, trade, railroading, and homesteading.

Both prehistoric and historic archaeological sites may exhibit surface characteristics with the potential to be affected by weed treatments. Perishable remains that could be affected include wood, paint, and other organic materials. In addition, sites may contain sources of information that could be potentially affected, such as datable remains, including wood for C14 dating, obsidian for hydration dating, intact thermal surfaces for archaeomagnetic dating, and residual materials on artifact and feature surfaces.

Archeological resource surveys have been conducted on the Custer National Forest. In general, the distribution of sites reflects the distribution of heritage resource survey; such that known sites that overlap inventoried weed infestations serve as an indicator of the extent of weeds within heritage resource sites. Since weeds have not been systematically inventoried and the distribution of heritage resource survey is a function of where projects have occurred, the existing sample of weed infestations compared to site distribution may not accurately reflect the true distribution of weeds across heritage resources.

The affected environment considered for this weed control project includes all areas containing heritage resources (archaeological and ethnographic resources) on the Forest, since new weed infestations may occur virtually anywhere on the Forest. However, the number of known heritage resource sites that overlap inventoried weed infestation sites is low. Approximately 260 acres of known heritage sites contain some level of weed infestation.

Weed control methods such as manual and mechanized ground-disturbing treatments would need to follow the protection measures outlined in Appendix C. Other methods, such as biological methods or direct hand application of herbicides to target weed species, were considered to have little or no effect on heritage resources and are exempt from further consideration under Section 106.

Because the project is designed to avoid direct impacts to archaeological sites (see Appendix C), it is anticipated that all sites will be avoided by mechanical treatments. If sites cannot be avoided, or if human remains are found during project implementation, the tribes, SHPO, and the Advisory Council will be contacted, and protection measures will be developed.

Ethnographic and Traditional Cultural Property Resources

Ethnographic and Traditional Cultural Property resources include sites and resources generally associated with living communities that have traditional and long-standing ties to an area. The Forest will consider other traditional or tribal concerns, especially if they fall within the purview of executive orders and other legislation. These may consist of physical remains, but they can also include areas of cultural importance such as communal or ceremonial locations without an obvious physical context.

On the Forest, these types of sites are generally associated with areas traditionally used by area tribal communities. The Forests have a unique relationship with Federally recognized American Indian tribes, and other traditional communities. As Federal agencies undertake activities that may affect a tribe's rights, property interests, or trust resources, they carefully implement those activities in a manner that respects

the tribe's sovereignty and resource needs. In addition, the NHPA requires an agency to evaluate effects to traditional cultural properties and practices within a project area.

Native Americans and other groups use the Forest to collect plants and animals for food, medicine and religious ceremonies, and wood for fuel and construction. Approximately 290 plant species have been documented to be used by various area tribal groups (i.e., Plains Native Americans and Montana Native Americans) and tribes, including Northern Cheyenne, Crow, Sioux, Bannock, and Shoshone (USDA, Forest Service, 1995. There are at least 170 plants documented as having current use by the Northern Cheyenne (USDI BLM and DNRC, 2002). Most of the plants identified are broadleaf forbs, while a few trees and shrubs are listed as well. Some grasses and grass-like species are also identified. Most of the weed species proposed for treatment do not appear to be those collected for traditional uses by Native American tribes associated with the Custer National Forest. The following species listed are noteworthy relative to their potential treatment as an undesirable species by some.

Curly cup gumweed (*Grindelia squarrosa*) and Broom Snakeweed (*Gutierresia sarothrae*), native species, are known to be treated as an undesirable species on some farms or ranches since they tend to increase with grazing pressure and are generally unpalatable to livestock. They are known to occur in isolated low elevation areas on or adjacent to the Forest, but are not typically priority plants for IPM treatment.

Yellow Sweet Clover (*Melilotus officinalis*), a non-native species, is known to be used for ceremonial purposes. It is known to occur in isolated low elevation areas on the Forest, but is not typically a priority plant for IPM treatment.

Rush Skeletonplant (*Lygodesmia juncea*) is listed for its medicinal use. It is a native species that should not be confused with Rush Skeletonweed (*Chondrilla juncea*). Rush Skeletonweed is a non-native species and a category 3 noxious weed targeted for eradication under Montana State law.

All other documented species are a desired native component to the desired condition of overall plant community health and diversity.

In locations off the Custer National Forest, weeds have invaded a number of the sites where these traditional-use plants grow. In general, the weeds can and have out-competed native plants, reducing plant populations and reducing the availability of these plants for traditional uses.

Although some specific areas are used as collection sites by specific clans, very few specific historic gathering sites have been identified on the CNF (USDA, Forest Service, 1996). Specific plant species and communities have special rules concerning their procurement and use. The specialized knowledge is only available to those tribal members who have the right to use the plants (USDI, BLM and MT DNRC, 2002; USDA, Forest Service, 1996). There are many areas of all three Districts of the Custer National Forest, where plant gathering for traditional ceremonial, medicinal, and subsistence purposes occurs. Where there are known special plant gathering areas (USDI, BLM and MT DNRC, 2002; USDA, Forest Service, 1996; and USDI, NPS, 1994), tribal consultation would be employed to adaptively add any new protection measures that might be needed to minimize effects to the plant population(s) in question (i.e., changes in weed treatment timing, application methods, treatment priority). Protection measures and adaptive management measures (Appendices C and E) would be employed.

SOCIAL AND ECONOMIC ASPECTS

Social and Economic Aspects - Regulatory Framework

There are no regulatory requirements for a social and economics analysis. However, it is an issue that was determined to be considered for this analysis.

Social and Economic Aspects - Analysis Area

The analysis area is considered the lands of the Custer National Forest, its associated eight counties of Montana and South Dakota, and another eight adjacent counties are within the zones of local influence of the Custer National Forest.

Social and Economic Aspects - Analysis Method

The source of information for the Affected Environment includes county and state found on the internet. The analysis is based on the potential for proliferation of invasive weeds if left untreated and proposed weed treatment activities that could impact social and economic aspects within the analysis area.

Social and Economic Aspects - Affected Environment

Population

The lands of the Custer National Forest occur in eight counties of Montana and South Dakota. Another eight adjacent counties are within the zones of local influence of the Custer National Forest. These 16 counties are referred to as zone counties.

The total populations of these 16 counties in the 2000 census were 273,520. Of this total, 47% people were in one metropolitan county (Yellowstone County, Montana). Nine of these counties have populations of less than 10,000 and six of those have populations of 5,000 or less. Thus, a “typical” zone-of-influence county has a population of about 9,600, with a county seat of perhaps 1,700, with various small settlements of between 40 and 800 people, and a rural population of about 3,000.

The 2000 population projection assumes a continuation of three trends: 1) additional growth in counties experiencing significant oil, natural gas, and coal development; 2) modest growth of counties serving these energy-producing counties as wholesale, retail, and service centers; and 3) modest growth of the counties in the Beartooth District due to the retirement amenities they offer, the recreational opportunities, and possibly the hardrock mining activity that is again increasing.

Economy

In the majority of the zone counties, agriculture and its related support services is the primary economic base. A few counties are experiencing high oil, natural gas, and/or coal development. However, their agricultural activities are still the long-term bases of their economy. Yellowstone County has business, manufacturing, professional services, and other economic foundations, as well as the agricultural components.

The average 2000 per capita income of people in the 15 rural zone counties was $32,900 for Montana and South Dakota, and the average of $36,700 for Yellowstone County (http://www.epodunk.com).

The primary agricultural component of this area has a strong interest in the control of weeds as it can affect many economic considerations.

Public Land Receipts

In 1908, in response to the mounting opposition to the creation of the National Forest System in the West, Congress passed a bill which created a revenue sharing mechanism to offset the effects of removing these lands from economic development. The 1908 Act specified that 25 percent of all revenues generated from the multiple-use management of the National Forests would be shared with the counties to support public roads and public schools. It was the intent of Congress in establishing our National Forests, that they would be managed in a sustained multiple-use manner in perpetuity, and that they would provide revenues for local counties and the federal treasury in perpetuity as well. And, from 1908 until about 1986, this revenue sharing mechanism worked extremely well. However, from 1986 to the present, multiple-use management receipts from the National Forests dropped sharply, and as a consequence, so did the

revenues. Most counties saw a decline of over 85 percent in actual revenues generated on our National Forests, largely as a result of the reduction in all forms of green and salvage timber harvesting.

In 2000, Congress passed the Secure Rural Schools and Community Self-Determination Act to address the negative effects of declining federal receipts on local governments. The Act is now authorized through September 30, 2013. Under the Act, counties are eligible for annual payments based on the value of the highest three-year average of the 25% fund between the years 1986 and 1999. Counties can wait to decide whether to opt into the program, but they may not withdraw from the program during the lifetime of the act. The following are fiscal year 2005 county payments for project affected counties in Montana.

FEDERAL FISCAL YEAR 2005 PL 106-393 FOREST RESERVE PAYMENTS - DECEMBER 2005[26]

County	Principal	Title I	Title III
Carbon	$ 53,543.35	$ 53,543.35	$ -
Carter	$ 14,456.71	$ 14,456.71	$ -
Park	$ 153,241.09	$ 130,254.92	$ 22,986.17
Powder River	$ 55,042.57	$ 55,042.57	$ -
Rosebud	$ 15,527.57	$ 15,527.57	$ -
Stillwater	$ 30,091.37	$ 30,091.37	$ -
Sweet Grass	$ 52,044.15	$ 52,044.15	$ -

Payments in Lieu of Taxes (PILT), conceived in 1976, are Federal payments to local governments that help offset losses in property taxes due to nontaxable Federal lands within their boundaries. Payment in lieu of tax public land receipts by county are shown in the following table.

TABLE 3 – 20. PILT REVENUES BY COUNTY

County	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005
Carbon County, MT	$ 515,820	$ 541,960	$ 613,244	$ 553,359	$ 591,318
Carter County, MT	$ 94,327	$ 99,002	$ 110,473	$ 112,769	$ 117,657
Park County, MT	$ 688,024	$ 723,202	$ 792,382	$ 815,523	$ 832,686
Powder River County, MT	$ 124,482	$ 131,131	$ 141,855	$ 113,630	$ 117,698
Rosebud County, MT	$ 365,274	$ 384,326	$ 433,077	$ 61,803	$ 64,482
Stillwater County, MT	$ 209,436	$ 220,596	$ 247,114	$ 251,505	$ 257,768
Sweet Grass County, MT	$ 262,470	$ 275,850	$ 306,812	$ 313,408	$ 318,443
Harding County, SD[27]	$ 97,956	$ 105,123	$ 111,920	$ 115,122	$ 118,781

The annual PILT payments to local governments are computed based on the number of acres of federal entitlement land within each county or jurisdiction with a cap based on population. Federal entitlement lands include Department of the Interior lands and water projects (National Park System, Bureau of Land Management, U.S. Fish and Wildlife Service and Bureau of Reclamation) as well as those of the U.S. Army Corps of Engineers and U.S. Department of Agriculture National Forest lands.

Individual county payments may increase or decrease from the previous year as a result of changes to acreage data, which is updated annually by the federal agency administering the land and population data updated by the Census Bureau. By statute, the per-acre and population variables used in the formula to compute payment amounts are subject to annual inflationary adjustments using the Consumer Price Index. The computation also adjusts the payment for the level of prior-year revenue payments and the amount that a county receives under Sections 6904 and 6905 of the PILT Act. Revenue payments are federal payments made to local governments under programs other than PILT during the previous year and include those made under the National Forest Fund, the Mineral Leasing Act, and the Secure Rural Schools and Community Self-Determination Act of 2000.

[26] http://maco.cog.mt.us/pages/FY-05ForestPayments&Worksheet.htm
[27] National Association of Counties:
http://www.naco.org/Template.cfm?Section=Find_a_County&Template=/cffiles/counties/pilt_res.cfm&state=SD and
http://www.naco.org/Template.cfm?Section=Find_a_County&Template=/cffiles/counties/pilt_res.cfm&state=MT

Economic Comparison of Treatments

This decision is about how to, not whether to, manage weeds on the Custer National Forest. This section provides the decision maker with comparative information on the relative costs per acre of the alternatives. The following table displays the experienced costs for each of the treatment methods being considered:

TABLE 3 - 21. ESTIMATED COST COMPARISON.

Treatment	Direct Cost per Acre
Biological Control	$150
Hand Pulling/Cultural/Mechanical - Average	$350
Ground Applied Herbicide – Average	$150
Aerial Applied Herbicide	$40

Biological control agents in general have not been in place long enough to show results on an area basis. The Custer averages about $750 per site or $150 per acre to collect and release bugs that prey on select invasive plant species.

Hand pulling is the only manual control practical on many parts of the forest. Four people can pull an acre of weeds in one day and the Forest Service commonly assigns this work to seasonal employees at the GS 3, 4 and 5 wage levels. A total cost per acre of $400 dollars is representative of the Forest's experienced costs on many of the more lightly infested sites. Cultural or mechanical work includes the use of fire, grazing, mowing, seeding and other activities that aid in achieving weed defense. A total cost per acre of $250 dollars is representative of the Forest's experienced costs. An average of $350 per acre will be used in this analysis.

Ground application commonly involves spraying an herbicide from a vehicle, usually a pick-up truck or an ATV. Experienced costs for ground application are approximately $100 per acre to apply Tordon 22-K®, the herbicide most commonly used on the Forest for spotted knapweed. Backpack sprayers cost a minimum of $200 per acre. This system is used less frequently than trucks or ATV's and the production rate (acres treated per hour) is less because applicators have to walk from one site to another. Difficult access increases the costs of these methods and access is frequently the limiting factor determining whether a site can be treated from a vehicle or on foot. An average of $150 per acre will be used in this analysis.

Aerial application costs include both fixed wing and helicopters. This analysis uses a value of $40 per acre since the areas to be treated tend to be small and few areas have been identified as suitable for aerial treatment.

The following table displays the reasonably foreseeable treatment acres, generated by GIS analysis of vegetative data, by treatment method and Alternative:

TABLE 3 - 22. TREATMENT ACRES (NET AREA) BY ALTERNATIVE[28]

Alt. [29]	Biological Control	Cultural/ Mechanical*	Ground Herbicide	Aerial Herbicide	Tall Larkspur Herbicide	Infrastructure Herbicide	Not Treated by Herbicide
1	155	5	1415	85	60	5	0
2	155	5	0	0	0	0	1340
3	155	5	1450	0	0	0	45

[28] Some acres are counted more than once because more than one species is present on the same site and each species may have unique treatment strategy.
[29] For all alternatives except Alternative 2, herbicides will be used in conjunction with biological, cultural, and mechanical control methods.

The following table displays the relative costs per acre, by Alternative:

TABLE 3 - 23. POTENTIAL ANNUAL[30] DIRECT WEED CONTROL ACRES BY METHOD

Alternative	Biological Control	Hand/Cultural/ Mechanical	Herbicide - Ground Application	Herbicide - Aerial Application	Herbicide - Tall Larkspur	Right of Way Undesirable Weeds	Total Annual Treatments
Alternative 1	$23,250	$1,750	$212,250	$3,400	$9,000	$1,750	$251,400
Alternative 2	$23,250	$1,750	$0	$0	$0	$0	$25,000
Alternative 3	$23,250	$1,750	$217,500	$0	$0	$0	$242,500

Average appropriations for weed control are about $130,000, annually. Expenditures are increased by various funds from grants and partnership projects.

Alternatives 1 and 3 show a total cost greater than the Forest is generally allocated to accomplish on an annual basis. Because of this reality, priority criteria have been developed in order to most efficiently utilize resources to combat weeds (see Appendix E). To give a more fiscally realistic portrayal of what the Forest weeds program could be expected to accomplish, the acreage figures in the following table were revised to (1) limit total annual costs to approximate historic budget amounts and (2) reflect the choices that have to be made when too few dollars are available to fully satisfy the objectives. The following table displays the acres by Alternative and treatment method that could be treated, assuming continuing budget support at historic levels:

TABLE 3 - 24. ANNUAL BUDGET DRIVEN WEED CONTROL ACRES BY METHOD

Alternative	Biological Control	Hand/Cultural /Mechanical	Herbicide - Ground Application	Herbicide - Aerial Application	Herbicide - Tall Larkspur	Right of Way Undesirable Weeds	Total Annual Treatments
Alternative 1	$7,500	$1,500	$114,100	$3,400	$3,000	$500	$130,000
Alternative 2	$23,250	$22,750	$0	$0	$0	$0	$46,000
Alternative 3	$7,750	$1,750	$117,500	$0	$3,000	$0	$130,000

The distribution of acres by treatment method and Alternative was guided by the following assumptions:

1. Table 3 - 24 reflects an estimated mix of treatment types. The Ranger Districts update their weed priorities each year and adjust treatment priorities accordingly to maximize long-term effectiveness.
2. Some early detection and mechanical pulling of small infestations remains a high priority under every alternative.
3. Cultural/mechanical treatment types: grazing, burning, seeding, etc while not currently given many acres will increase as technology and native seed sources improve. Emphasis is currently directed towards those wildfire areas having a potential weed problem following a high intensity, high severity burn.
4. Current biological control agents on the Custer National Forest have had limited success in limiting weed spread to date. More emphasis will be given to these agents as their effectiveness and spread improve.

The following table lists approximate retail prices (2005) for small quantities for some herbicides[31]. Herbicide prices do not include cost of such additives as surfactants, oils, fertilizer or application costs. Prices may vary depending on area of the state, wholesaler, bulk discounts, seasonal changes, quantities purchased and particular programs the manufacturing company offers. Prices are averages based on statewide dealer survey for small quantities. Producers should consult local agricultural product suppliers for exact price of each product in their area.

---

[30] Right-of-Way herbicide treatment is estimated to be done every four years
[31] NDSU, 2005. http://www.ag.ndsu.nodak.edu/weeds/w253/w253-5c.htm

TABLE 3 - 25. COST PER UNIT BY HERBICIDE

Product	Active Ingredients	Formulation	Cost $/Unit	Product/A			Cost $/A		
				Low	Med	High	Low	Med	High
Redeem Dow	clopyralid-tea + triclopyr-tea	0.75 + 2.25EC	92.00 gal	1.5 pt	2.5 pt	4 pt	17.25	28.75	46.00
Remedy Dow	triclopyr ester	4EC	92.00 gal	1 qt	1.5 qt	2 qt	23.00	34.50	46.00
Rifle D UAP	2,4-D-dea + dicamba-dea	2.87 + 1SL	26.00 gal	0.5 pt	2 pt	4 pt	1.65	6.50	13.00
Rodeo Dow	glyphosate-ipa salt	4SL	50.00 gal	0.75 pt	1.5 pt	3 pt	4.70	9.40	18.75
RU Original Max Mons	glyphosate-K salt	4.5SL	30.00 gal	0.67 pt	1.33 pt	2.67 pt	2.50	5.00	10.00
RU UltraMax II "	glyphosate-K salt	4.5SL	56.00 gal	0.67 pt	1.33 pt	2.67 pt	4.70	5.50	11.00
RU WeatherMax "	glyphosate-K salt	4.5SL	56.00 gal	0.67 pt	1.33 pt	2.67 pt	4.60	9.15	18.35
RT Master II "	glyphosate-K salt	4.5SL	26.00 gal	0.67 pt	1.33 pt	2.67 pt	2.20	4.35	8.70
Sahara BASF	imazapyr acid + diuron	7.78 + 62.2WDG	11.00 lb	5 lb	10 lb	15 lb	55.00	110.00	165.00
Salvo PC UAP	2,4-D ester	5EC	26.00 gal	6.4 fl oz	9.6 fl oz	12.8 fl oz	1.30	1.95	2.60
Sterling Agriliance	dicamba-dma salt	4SL	82.00 gal	2 fl oz	1 pt	4 pt	1.28	10.25	40.95
Stinger Dow	clopyralid-monoea salt	3SL	480.00 gal	0.25 pt	0.5 pt	0.67 pt	15.00	30.00	40.00
Telar DuPont	chlorsulfuron	75DF	22.00 oz	½ oz	1 oz	3 oz	11.00	22.00	66.00
TopSite UAP	imazapyr acid +diuron	0.5 + 2G	3.50 lb	200 lb	250 lb	300 lb	700.00	875.00	Too much
Tordon 22K Dow	picloram - K salt	2SL	92.00 gal	1 pt	2 pt	4 pt	11.50	23.00	46.00
Touchdown CF Syng	glyphosate - diammonium	3SL	17.00 gal	1 pt	2 pt	4 pt	2.15	4.25	8.50
Touchdown HiTech "	glyphosate - K salt	5SL	30.00 gal	10 fl oz	30 fl oz	40 fl oz	2.35	7.05	9.40
Touchdown iQ Syng	glyphosate - diammonium	3SL	24.00 gal	1 pt	2 pt	4 pt	3.00	6.00	12.00
Touchdown Total "	glyphosate - K salt	4.17SL	32.00 gal	12 fl oz	24 fl oz	48 fl oz	3.00	6.00	12.00
Transline Dow	clopyralid-monoea salt	3SL	350.00 gal	0.67 pt	1 pt	1.33 pt	29.30	43.75	58.20
Velpar DuPont	hexazinone	2L	60.00 gal	2 pt	4 pt	6 pt	15.00	30.00	45.00
Weedone 638 Nufarm	2,4-D acid + 2,4-D ester	2.8EC	23.00 gal	0.67 pt	2 pt	3 pt	1.95	5.75	11.50
Weedmaster BASF	2,4-D-dea + dicamba-dea	2.87 + 1SL	26.00 gal	0.5 pt	2 pt	4 pt	1.65	6.50	13.00
2,4-D Products	2,4-D								
2,4-D amine		3.8SL	12.00 gal	0.5 pt	2 pt	4 pt	0.75	3.00	6.00
2,4-D ester		3.8EC	14.00 gal	0.4 pt	2 pt	4 pt	0.70	3.50	7.00
LV ester		5.7EC	18.00 gal	0.33 pt	2 pt	4 pt	0.75	4.50	9.00

Lifestyles

The population is largely rurally oriented, with strong ties to the land and to the many small towns. The population of Yellowstone County (includes Billings, Montana) is roughly 65% urban and 35% rural.

Ranch and farm families constitute 25% or more of the populations of six of the zone counties. These long-time residents exert considerable political and economic influence, and tend to favor traditional land uses and the preservation of intergenerational family operations. Another 25% or more of the populations in a majority of the counties are long-established small town residents.

Another 10% of the populations outside of Yellowstone County are Native Americans, and largely are residents of five different Indian reservations in or near the zone counties.

In recent years, the areas of major mineral activity have seen an influx of people from other areas. Many of these people regard their employment as temporary, expecting to move on to other areas, and usually do not play an integral part in community affairs.

Another distinct group is a small but growing population of professionals, craftsmen, retirees, and others who have moved to small towns to enjoy the slower pace of life and various amenities.

Lastly, Yellowstone County is growing, with a wide diversity of business, manufacturing, transportation, medical, educational, and cultural components, as well as significant agricultural components outside of the immediate metropolitan areas. The population of Billings, Montana is cosmopolitan when compared to the rural areas and smaller towns, and have attracted people from many parts of the Nation. The people of this area view the National Forest primarily as valuable recreational areas rather than as integral parts of their economies.

Many of these lifestyles integrate with the enjoyment or use of the Custer National Forest's native habitat components that invasive weeds can drastically alter when not aggressively managed.

Partnerships and Collaboration in Weed Management

Invasive plants spread across landscapes, unimpeded by municipal, state, international, and other physical and political boundaries. Behaviors of forest users and neighboring landowners influence the effectiveness of Forest Service actions to control weeds. Partnership and cooperation with forest users, neighboring landowners, and other stakeholders increase invasive plant prevention program effectiveness. Scoping comments applauded partnership and collaboration efforts in invasive plant management, and expressed that such efforts should be increased. The 2004 "National Strategy and Implementation Plan for Invasive Species Management" (http://www.fs.fed.us/news/2004/releases/10/invasives-species.shtml) emphasizes partnerships and collaboration at all levels of the agency and across all programs. Beartooth Weed Management Area is an example of such partnerships.

CHAPTER 4
ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

This chapter discloses the direct, indirect and cumulative effects of the alternatives described in Chapter 2. The affected environment and methodology for analysis was addressed in Chapter 3.

DIRECT AND INDIRECT EFFECTS

Direct effects are caused by an action and occur at the same time and place. Indirect effects are caused by an action and occur later in time or farther removed in distance, but are still reasonably foreseeable.

Direct and indirect effects analysis for each alternative and each resource area are based on the description of the alternatives provided in Chapter 2, including the protection measures described under each alternative and under Features Common to All Alternatives section.

Also, every resource assumed that all acres indicated in Chapter 2 would be treated in each of the alternatives. Due to the way the inventory and mapping was done, treatment acres may be less than those indicated. This is mostly caused by areas of light or no weed infestation being included within a weed location "polygon" in the mapped database. The minimum size of a weed polygon is 0.01 acres, where the actual size might be one plant or a small patch.

CUMULATIVE EFFECTS

Cumulative impacts are impacts on the environment that result from the incremental impact of actions when added to other past, present, and reasonably foreseeable future actions. For each resource, an analysis area was identified and used to adequately measure cumulative effects of the proposed alternative. Unless otherwise stated, the cumulative effects area, or the geographic scope, is the treatment area. For temporal scope, the timeframe for project implementation is 15 years and an additional five years past the final implementation year is considered.

PAST PRESENT AND REASONABLE FORESEEABLE ACTIVITIES

Weed control efforts including aerial and ground application of herbicides will continue on privately-owned and public lands within and adjacent to the Custer National Forest. Government agencies such as the National Park Service, Bureau of Land Management, Gallatin National Forest, Shoshone National Forest, Bighorn National Forest, Black Hills National Forest, Montana Fish Wildlife and Park, Montana State University, Montana and South Dakota Highway Transportation Departments, Montana and South Dakota State Public Lands, local municipalities, Stillwater County, Park County, Carbon County, Sweet Grass County, Powder River County, Rosebud County, and Carter County of Montana, along with Harding County of South Dakota all use herbicides to control weeds adjacent to the Custer National Forest.

Activities that alter vegetation and may potentially act as a weed vector such as wildfires, timber harvesting, fuel reduction, livestock grazing, and recreational uses (hunting, hiking, motorized recreation,

etc.) will continue to dominate the landscape. The reasonably foreseeable and ongoing (previously planned) activities on NFS lands considered in the effects analysis are shown in Tables 4 – 1 and 4 - 2.

The Forest Service has developed prevention and protection measures (environmental design criteria) (Appendix C) that minimize the impacts of these activities on weed spread (FSM 2080). The Best Management Practices for Weed Control is listed in Appendix C.

TABLE 4 – 1. REASONABLY FORESEEABLE ACTIVITIES[1]

Project Name	Type of Project
Beartooth Ranger District	
Beartooth Communications Sites	Facility Management
Grizzly Peak Fuel Management	Fuels Management
Piney Creek Pool Enhancement	Fisheries Habitat Management
Meyers Creek Area Grazing Allotment Planning	Grazing Management
Beartooth Front Grazing Allotment Planning	Grazing Management
Sage Creek Assessment and Forest Plan Amendment	Grazing Management
Big Ice Cave Withdrawal	Land Ownership Management
Kalt and Gans Land Exchange	Land Acquisition
Stillwater Mining Company, Closure and Post Closure	Minerals Management
Jimmy Joe Campground Reconstruction	Recreation Management
Beartooth Travel Plan	Road Management
East Rosebud Road #2177, Bridge Reconstruction	Road Management
Luoma Road Right of Way Permit	Road Management
Mickelson Water Pipeline Special Use Re-issuance	Special Use Management
Lions Organization Camp Special Use Permit Re-issuance	Special Use Management
TCT West Inc. Right of Way Re-issuance	Special Use Management
Quad Creek Stream Channel Restoration and FSR #2421 (Glacier Lake Road) Repair and Maintenance	Watershed/Road Management
Forest Plant Amendments for Grizzly Bear habitat Conservation for the GYA National Forests	Wildlife Management
Northern Rockies Lynx Amendment	Wildlife Management
Ashland Ranger District	
Hanson Prescribed Fire	Fuels Reduction
Roundup Prescribed Fire	Fuels Reduction
Ten Mile Prescribed Fire	Fuels Reduction
Timber Creek Prescribed Fire	Fuels Reduction
Whitetail Hazardous Fuels	Fuels Reduction
Stag Rock Grazing Allotment Analysis	Grazing Management
Sioux Ranger District	
Slim Buttes Range Analysis	Grazing Management
Long Pines Range Analysis	Grazing Management
Sioux Oil and Gas Leasing EIS	Minerals Management
West River Telephone Special Use Permit Amendment	Special Use Management
Verhuist Stockwater Pipeline SU Permit Re-issuance	Special Use Management

[1] Source: January 2006 Quarterly Schedule of Proposed Actions, Custer National Forest.

TABLE 4 – 2. ONGOING / UPCOMING ACTIVITIES CONSIDERED IN CUMULATIVE EFFECTS

Project Name	Type of Project
Beartooth Ranger District	
Beartooth Aspen Treatment	Wildlife Management
Locatable Minerals Development; Stillwater Mine Company operations	Mineral Management
Plan of Operations - Stillwater Complex (~ 3 three annually) for locatable minerals	Mineral Management
Pryor Mtn reclamation of two. Abandoned uranium mines	Mineral Management
Potential gas exploration /development – Line Creek Face (MT/WY)	Mineral Management
Adjacent to NFS - Pryor Mtn. Limestone Existing Operations (~ 200 Ac) and potential expansion (~300 Ac)	Mineral Management
Ashland Ranger District	
Powder River Gas Pilot Project (East of District)	Mineral Management
Sioux Ranger District	
Oil and Gas Exploration and Development – N & S Cave Hills, E & W Short Pines and adjacent to these land units	Mineral Management
CERCLA – Riley Pass reclamation (~ 300 Ac)	Mineral Management
Potential abandoned uranium mine reclamation	Mineral Management
Potential Tongue River Railroad (in or adjacent to District)	Mineral Management
Potential Energy Development related Power Line Corridors (2) in or adjacent to District	Mineral Management
Otter Creek Coal Tract Exploration / Development (~ 11 sections adjacent to District)	Mineral Management
Custer National Forest-Wide	
Fuels Treatments (~ 1200 Ac annually)	Fuels Management
Timber Sales	Timber Management
Permitted Grazing (~550,000 Ac)	Grazing Management

SHORT TERM USE VS. LONG TERM PRODUCTIVITY

Unless otherwise specified, short-term effects are those that occur within three years after treatment. Long-term effects are those that occur after three years from last treatment.

IRREVERSIBLE / IRRETRIEVABLE

National Environmental Policy Act requires identification of irreversible and irretrievable commitment of resources. These effects are identified in resource areas where they may occur including soils, vegetation, water, and special areas such as Wilderness, inventoried roadless areas, and Research Natural Areas.

ENVIRONMENTAL JUSTICE

Executive Order 12898 requires federal agencies to incorporate environmental justice into their missions by identifying and addressing high and adverse human health or environmental effects in their programs and policies on minorities and low-income populations and communities. None of the project alternatives would result in disproportionate impacts on minority or low-income populations or communities. Polluting facilities are not being proposed in this analysis. Environmental standards will be applied equitably across the National Forest with the same level of regulatory protection as other groups that may be wealthier, more politically powerful, or of a different race. There will not be inequitable distribution of project impacts as weed treatment can be accomplished across the National Forest regardless of low income or minority populations in the regional area.

ENERGY REQUIREMENT

None of the alternatives being considered for this project have unusual energy requirements.

NATIVE AMERICAN TREATY RIGHTS

While the alternatives may have differing impacts on species or their habitat none of the alternatives would alter opportunities for Native American tribes holding treaty rights to hunt and gather.

ADVERSE EFFECTS THAT CANNOT BE AVOIDED

There are no adverse effects associated with this project identified in the analysis that cannot be avoided. Protection measures listed in Appendix C will be implemented and will mitigate any adverse effects from weed control.

VEGETATION

This section is divided into three main categories (weed species, native plant communities, and rare plants) and will evaluate the effects of the alternatives along with the cumulative effects.

EFFECTS OF NON-HERBICIDE TREATMENTS COMMON TO ALL ALTERNATIVES

Effectiveness of various non-herbicide treatments by target species are displayed in Appendices F and J.

Mowing would remove most above ground vegetation in treated areas and may damage or kill non-target vegetation. Mowing would mainly decrease the amount of seed production of weeds. Mowing could also weaken root and rhizome systems of creeping perennial weeds.

Tilling would injure top growth and the upper 12 inches of the underground systems of all vegetations within the treatment area. Depending upon the specific site, the moisture situation and the species (target or non-target), this method tends to have limited effectiveness. Tilling can break up the rhizomes of weeds that are creeping perennials, encouraging greater growth. It could also create a seedbed for other weed seed, thus promoting further spread. Reproduction of weeds by seed can be greatly reduced by seeding the site with native species shortly after tilling. The extent and location of tilling activities would be limited by terrain and soil characteristics.

Prescribed burning would suppress competing vegetation. Burning would promote regeneration of some grasses, forbs, and hardwoods, but could destroy some non-sprouting shrubs and other trees. Some noxious weeds such as leafy spurge regenerate rapidly from their root system after a burn and compete with desirable species. The control of such species might thus require burning followed by applying low rates of herbicides.

Sheep and goats have been used to a small degree for leafy spurge control. They tend to only graze on certain biological types of leafy spurge and remove only the top growth. Since the greatest consumption of leafy spurge is about 50%, sheep and goats could also consume some non-target species during the treatment period, depending upon management by the herder. However, if need be, very little non-target vegetation needs to be eaten during this type of spurge treatment.

There are only a few insect which are effective in controlling specific weeds (see Appendix I). No significant detrimental impacts to non-target vegetation would result from the use of insects or pathogens under any alternative due to the state and Federal clearances needed before a release of these agents.

WEED SPECIES, DIRECT AND INDIRECT EFFECTS - ALTERNATIVE 1 (PROPOSED ACTION)

Under this alternative various pest management practices such as pulling, biological control, and herbicide treatment would be used in combination to control, contain and/or eradicate populations of weed species. Aerial application of herbicides is also provided, thus, larger or remote infestations can be treated in a safe, efficient, and economical manner. The most effective means for control and/or eradication would be chosen depending on the likelihood of long-term effectiveness or resource values at risk. Appendix E, Table E – 1 would generally guide actual treatment priority with emphasis generally being given to new invaders and species having the greatest risk of spread.

This alternative provides for the maximum use of integrated pest management methods. This alternative provides for treatment of 1,500 net infested acres (approximately 14,000 managed gross acres) of noxious weeds, 60 net acres tall larkspur, and 5 net acres for infrastructure maintenance (i.e., paved road shoulder maintenance). See Chapter 2 for specific proposed action. Historic funding levels have allowed for about 600 – 1,200 acres of treatment. A majority of the current weed sites are less than one tenth acre in size and still very manageable. Treating the small satellite populations and keeping those priority weeds in "check" will limit spread into new areas.

Efforts to utilize the most selective herbicide would be considered. This alternative provides for the use of a wide variety of herbicides that have a wide range of plant selectivity. Glyphosate and Diuron is the least selective, affecting most plant species. Clopyralid is the most selective herbicide, affecting only plants in the sunflower (Compositeae), buckwheat (Polygonaceae), nightshade (Solanaceae), and pea (Fabaceae) families. Seven of the thirteen existing Custer Forest weed species are in these families. Dicamba, Picloram, and 2, 4-D-amine are less specific. Monocots (grasses, grass-like plants, lilies, orchids and related families) are tolerant of Dicamba because of rapid metabolism (Sheley and Petrof, 1999); however, when mixed with other herbicides, it may be more lethal to some broad-leaved monocots. Picloram and 2, 4-D appear to be effective on all species except grasses (Poaceae). Conifers have variable response to herbicides, but many are negatively affected by most herbicides.

Currently, all of the Custer National Forest weed species are broad-leaved species. Application rate and extent of coverage, either spot or broadcast, can affect what plant species are impacted by the herbicides. Many of the species can be protected through following label application limits and specified protection measures (see Appendix C). The timing of application and rotation of herbicides may also be important in limiting impacts to non-target native vegetation. This alternative provides for additional herbicide families to choose from that would not be used in Alternatives 2 and 3. Rotating between these family groups of herbicides that are selective in nature will significantly limit potential damage to non-target native plants. Impacts to native plant communities and rare plant species can be greatly reduced while still controlling the weeds on the site.

Aerial application will greatly increase the efficacy of the weed control program on the larger, more remote sites. Weed densities can be greatly reduced through broad scale treatments. Ground crews will have more time to focus on the smaller, scattered infestation, prior to the weeds increasing to the point where control efforts become overwhelming. Aerial treatment is a valuable tool in areas where weeds become established on the steeper slopes or where terrain is a safety concern.

Manual control of areas is anticipated to be less than 5 acres each year on sites that have very few plants, and/or where the plants have already established viable seed before herbicide treatment occurs. Manual methods are very labor intensive and generally effective only on weed species that do not have extensive root systems. For treatment to be effective the site needs to be checked multiple times during the growing season to prevent weeds from going to seed. The site must also be treated yearly until the weeds are eradicated. This method is primarily used where a few plants exist, and in sensitive areas such as adjacent to open water or high water table sites. It is also used where threatened, endangered or sensitive plants species are present and other control methods would harm the rare species.

The biological control program on the Custer National Forest would be expanded to include new sites, when necessary, as a secondary form of control. The effectiveness of other control measures would limit the need for focusing much attention on the use of biological control agents. Coordination with Animal

Plant Health Inspection Service (APHIS) and other affiliations to release and monitor current and new control agents would occur. Use of biological control agents would be focused on sites outlined in Appendix E. The nature of biological control agents is to reduce density and seed production of the target weed, not necessarily to contain or eradicate the species. Multiple biological control agents that work on different parts of the plant tend to be more successful than relying on a single agent. Two weed species, leafy spurge and musk thistle, have biological control agents that are showing promising results in reducing plant density and coverage. A pathogen for houndstongue, not yet available, is looking very promising as an effective control agent.

Cultural control would also be encouraged in cheatgrass (*Bromus techtorum*) communities to encourage re-establishment of native bunchgrass communities. Removing unwanted weeds would involve herbicidal control, possibly seedbed preparation, and seeding.

Kentucky bluegrass, timothy grass, crested wheatgrass, or smooth brome communities are currently considered economically unfeasible to convert back to native communities through cultural methods. However, these communities would be encouraged to be converted back to native systems as native seed sources or techniques become economically feasible.

Under this alternative, various pest management practices such as mowing, pulling, biological control and herbicide treatment would be used in combination to control, contain and/or eradicate populations of invader species. The most effective means for control and/or eradication would be chosen depending on the species and site conditions. See Appendices F and J for treatment effectiveness by species. Also, different approaches would be considered for the different categories of invader species. Key to the effectiveness of this strategy will be knowledge of the distribution and abundance of invaders. See Appendix E for treatment priority criteria.

Category 1 Species - Because most of these species exist in extensive, widespread infestations, a great deal of resources would be required to reduce or eradicate populations. For especially hardy species with extensive root systems, eradication of large infestations could prove to be impossible since we do not have the tools or technology to effectively kill all plant parts and prevent re-growth (Sheley and Petroff 1999). Therefore, the key management approach with these species is to control and contain existing populations (keep them from spreading into uninfested areas) and to eradicate new populations in uninfested areas. The IPM approach is to prevent Category 1 species from spreading beyond current infestations. Therefore, Category 1 invaders would not necessarily be eliminated, but infestation spread into uninfested native plant communities would be reduced under this alternative.

Category 2 Species - Some infestations of Category 2 species are relatively large, yet they are still geographically limited to only a portion of the Custer National Forest. For this reason containment is the primary goal. If contained, many of these Category 2 species can be eradicated if acted upon immediately thus preventing these new invaders from affecting native plant communities. If eradication is not possible, then control and containment is the goal to at least limit the impacts these species would have on the native ecosystem. Category 2 invaders should therefore be prevented from infesting new areas, and should be eliminated in some existing populations, while the remainder would be contained under this alternative.

Category 3 Species - These invaders are the highest priority for control. The discovery of any new populations would prompt immediate eradication action using the most efficient IPM approach. No populations of Category 3 invaders would be allowed to persist under this alternative.

WEED SPECIES, DIRECT AND INDIRECT EFFECTS - ALTERNATIVE 2 (NO HERBICIDE)

This alternative does not rely on herbicides for controlling weed infestations. Manual, cultural, and biological control methods would be used to control weeds on the Custer National Forest. Only about 10% of the current weed infestations could be treated under this alternative. This alternative would result in 1,340 net infested acres not being treated for the following reasons: (1) there is not an approved biological control agent or very limited effectiveness; (2) the weed patch is too large and can not be hand pulled because of lack of resources; and/or (3) the plant spreads via roots and extensive soil disturbance is not acceptable.

Manual methods of control are very labor intensive and generally effective only on weed species that do not have extensive root systems. Biological control agents would be the primary method used and this tool has had very limited effect on controlling the density of most weed species. At the present time, the Forest has found leafy spurge flea beetle effective in reducing the spurge density on some dry sites. Other biological control agents released on adjacent Forests have not made a noticeable change in weed density. In the future as biological control agents become more abundant and other insects become available, then this may become a more effective tool. Manual methods can be effective in localized sites. However, even with the relatively small amount of weed infestations on the Custer National Forest it is impossible to make any meaningful control effort by the use of manual methods.

Pulling can be effective on new infestations or very small sites with a low plant density. For treatment to be effective the site needs to be checked multiple times during the growing season to prevent the weeds from going to seed. The site must also be treated yearly until the weed is eradicated. Pulling would kill the individual plants that are removed so long as the entire root is taken. Pulling is not effective on species with extensive root systems, like those of leafy spurge or Canada thistle.

Mowing or use of a weed whacker can be used to prevent weed species from going to seed. This is a very long-term control method. If you can keep the weed from producing seed eventually the individual plants may die out. Again this is only for species that reproduce primarily by seed. Weeds with extensive root systems would not be affected. In fact many such species are stimulated to increase their root systems when their tops are cut. Control by mowing is similar to pulling; the site must be retreated multiple times during the growing season to prevent the plant from producing any seeds. The site also must be treated each year or the benefit of the previous year's treatment is lost.

A variety of biological control agents are present on the Custer National Forest. Coordination with Animal Plant Health Inspection Service (APHIS) to release and monitor current and new control agents will continue. Use of biological control is the primary focus for weed control under this alternative. The nature of biological control agents is to reduce the density and seed production of the target weed, not to contain or eradicate the species. At this time most biological agents have not shown significant effects on the majority of weed species. Two weed species, leafy spurge and musk thistle, do have biological agents that are showing promising results in reducing plant density and coverage. Currently no biological control agent has shown an ability to control or reduce the spread of any Custer National Forest weed species.

This alternative provides for 155 acres of treatment with biological agents. Biological control agents could be released on all weed infestations where appropriate, but until such time as they become effective at reducing the density and spread of these weeds no effective control is expected. The risk of weeds taking over a majority of the sites depicted in Chapter 3, Table 3 - 7 becomes more probable.

The threat of herbicides impacting native plant communities is far exceeded by weeds displacing plants under this alternative.

Since the late 1800s, exotic plant species have been spreading across the Pacific Northwest. It is clear when studying distribution records of exotic plant species over time that the number is increasing and that all expand their range once they are established (Rice 1999). In studying these records it is apparent that more species have invaded over time and that all species have increased their range. Based on these historic trends, we expect that these patterns of expansion will continue due to transport of seeds from increasing intercontinental travel and trade, and through continued disturbance on all lands (through agricultural, residential, recreational and commercial developments).

The CNF is no exception to the trend of increasing travel. Recreational and commercial use on the CNF allows the transport of seeds onto sites that are favorable for establishment. Due to the adjacent land ownership patterns within and around the CNF boundaries, weed infestations are likely to continue spreading from non-CNF lands. The number of invader species and their distribution on the CNF will, therefore, only increase if limited action is taken to prevent their introduction or to control their spread.

Category 1 Species - Although Category 1 species are already widely distributed on the CNF outside the Absaroka-Beartooth Wilderness, there are still many uninfested areas. Based on past trends of these species, it is reasonable to assume that without some increased methods of control, these areas will

become invaded in the near future, as well. Also, where the density of invaders is currently low infestations will likely increase. The areas identified in the risk assessment for Category 1 species are where these changes are expected to occur. Under the no-action alternative, some treatments would still include using biological control agents, mechanical measures such as hand pulling and mowing, and limited application of herbicides. However, given the widespread nature of species in this category, these measures alone without the increased use of herbicides will have little effect on preventing the introduction and further spread into uninfested areas.

Category 2 Species - These species are the most likely to significantly expand to new areas on the CNF in the immediate future if no increased action is taken to control or eradicate populations. This is because these species have already infested a portion of the Forest, and are currently escalating. Some of these Category 2 species have shown highly aggressive tendencies like Salt Cedar that has been found on the Ashland District and is adjacent to the Beartooth District.

Category 3 Species – Common crupina has been documented as occurring on the Sioux Ranger District. Species in this category are some of the most highly aggressive exotics known, and are rapidly spreading in our direction. Once these species are established on the CNF, it is expected that they would move rapidly and likely infest areas identified at risk if no action were taken to eradicate new populations.

Measures that do not involve the use of herbicides may prove effective with some newly discovered populations of Category 3 species, particularly if found when infestations are still very small. For others, where non-herbicide control measures have proven to be ineffective, their spread would likely continue.

WEED SPECIES, DIRECT AND INDIRECT EFFECTS - ALTERNATIVE 3 (NO CHANGE FROM CURRENT MANAGEMENT)

This alternative is the same as current management practices covered by previous NEPA decisions. No additional herbicide treatment would occur outside of those areas identified in the 1987 Custer National Forest Noxious Weeds Control EIS and the 1987 West Fork Rock Creek EA. Alternative 3 would allow treatment of noxious weed species on known infestations (1455 acres) outside of the wilderness using only four herbicides (2, 4-D, picloram, dicamba, and glyphosate). This alternative also allows for manual, cultural, and bioagent treatments. This alternative would not treat infestations within the AB Wilderness Area (about 45 acres) with herbicides because it was not analyzed in the previous environmental analysis. Aerial treatments would not be done under this alternative. Rapid spread of weeds on those sites not previously approved for treatment would occur.

WEED SPECIES, CUMULATIVE EFFECTS

Invasive weeds are an ongoing battle, especially where eradication is not likely. The odds of having an effective eradication program improve drastically with treating weeds before they become established through seed reserves and/or extensive root networks. The adaptive management approach as designed in Alternative 1 best provides for early detection and eradication.

Biological control is a slow and long-term process, especially in Alternative 2 where it is the primary form of control. While biological control agents have not successfully eradicated any one species on the Custer Forest they have softened the impacts for some species such as leafy spurge.

Alternative 1 would add to efforts ongoing by adjacent counties and ownerships to control weeds surrounding the Custer National Forest. Other landowners, including private and corporate owners, State, and others would benefit from reduced weed populations on the Custer Forest. Actions under these alternatives would allow the Custer Forest to work closer with surrounding landowners, counties, and other land management agencies to be more effective at controlling and containing weed infestations.

Under Alternatives 2 and 3, since the effectiveness of the weed control will be reduced, adjacent land owners will see an increase in weeds spreading from the Forest lands onto their lands over time.

NATIVE PLANT COMMUNITIES, DIRECT AND INDIRECT EFFECTS - ALTERNATIVE 1 (PROPOSED ACTION)

There is little doubt that measures taken to control weeds will kill some non-target, native plant species. It is important to note that although most weed control activities may kill some individual native plants, the action would be intended to prevent the far greater loss of species diversity and ecosystem processes resulting from further uncontrolled weed infestations. Impacts to plant communities are reduced when control actions are taken at an early stage of invasion. Affects on plant communities increase as weed infestations expand in size and density. The increased impacts come not just from the weeds but also from the control measures. When treatments must be broadcast across an entire area and not specifically focused on the target plant, control measures have a greater potential for negative impacts. This is true for manual, biological, and herbicide treatment methods.

Just as changes in plant diversity or species composition can occur due to invasive plants, changes can also occur due to treatments. Short-term changes in species dominance can lead to long-term shifts in plant community composition and structure. Repeated treatments over time could favor tolerant species, which in turn could shift pollinators available to a community.

DiTomaso (2001) points out that continuous broadcast use of one or a combination of herbicides will often select for tolerant plant species. When broadleaf selective herbicides are used, noxious annual grasses such as cheatgrass may become dominant. Population shifts through repeated use of a single herbicide may also reduce plant diversity and cause nutrient changes. For example, legume species are important components of rangelands, pastures, and wildlands, and are nearly as sensitive to clopyralid as yellow starthistle. Repeated clopyralid use over multiple years may have a long-term detrimental effect on legume populations. Thus, a variety of integrated treatments would most likely avoid adverse impacts to native plant diversity.

Kennedy et al. (1999) summarized studies related to biodiversity and ecosystem functioning. Recent theoretical models predict that decreasing plant diversity leads to lower plant productivity. These models also showed diversity and composition are equally important determinants of ecosystem functioning. Maintaining biodiversity is often one of the primary goals of ecosystem management. Reductions in diversity may destabilize trophic dynamics, alter wildlife populations and change nutrient cycles or decomposition rates (Alpert, et. al., 1997).

Conifer forests are susceptible to changes in ectomycorrhizal fungi. Ubiquitous in most forests, their complex network of fungal hyphae increase the effective rooting area of host trees, often leading to improved nutrient uptake, seedling survival, and growth (Busse et al, 2004). Adverse effects on ectomychorrhizal fungi and on edible mushrooms from herbicide use have not been demonstrated in laboratory studies (ibid.).

Pulling target weeds has little effect on native vegetation. This is due primarily to the very limited area that can be effectively treated by this method and the fact that you are pulling just the target plant. Pulling may affect adjacent plant species due to soil disturbance when removing the entire root system. Significant soil disturbance is rare and generally only seen where weed densities are very high. Mowing may reduce the vigor and reproductive ability of native plant species, which are mixed in with target weeds. As the goal of mowing is to prevent weed species from producing viable seed, timing of the treatment can be used to reduce the impacts to native species. For either of these methods the extent of their use is very limited and the proportion of native plant populations affected would be very small.

Biological control agents are rigorously selected and screened to prevent impacts to non-target species. Not all native species are tested for each new agent. A few biological control agents released prior to the current, more stringent screening protocols, have been found to feed on native plant species. Their impacts have not fully been evaluated. In general, biological control agents are useful in native plant communities because they avoid other non-target vegetation. The Custer National Forest will rely on the updated screening process being followed for biological control agents. None-the-less, because of the remote possibility of effects to native plant species from biological control agents, the Forest will review decisions to release new agents on the Forest.

Use of herbicides has the highest potential to impact native plant communities. Herbicide use will kill non-target plants. The degree of mortality of native species depends on the herbicide used, and the application method, and rate and frequency. As discussed earlier, the herbicides to be used range in their effects on plant species. Clopyralid is one of the most selective and glyphosate is a non-selective herbicide that will kill most plant species including grasses.

Of the proposed application methods, aerial application is most likely to affect non-target native plants. This is because this method indiscriminately applies herbicide to all plants in the treatment area. Also, drift can affect plants outside the treatment area. However, protection measures would be taken to minimize drift. Spot applications with backpack sprayers, truck mounted sprayers or wick applicators focus the herbicide on the target weeds with limited treatment to adjacent non-target vegetation. These methods would affect native species the least.

Under this alternative, Integrated Pest Management strategy methods that would be most effective on controlling invaders, while minimizing impacts on native species would be used. This approach would help decrease the effects of herbicide use. In addition, as only a small portion of the overall infested areas would be treated, the impacts to common native plants are insignificant as they relate to species abundance, distribution, and population viability on the Custer National Forest. Relative speaking, this alternative has the best odds of keeping those potential areas identified in at high risk from becoming weed infested.

This alternative will, in the short term, affect more native plants due to the broadcast application of herbicides by aerial application than the other alternatives. In the long tern this alternative will protect more native plants and plant communities because of the same actions. Being able to treat a large number of infested acres will greatly improve the probability of controlling many of the weed species currently found on the Forest.

NATIVE PLANT COMMUNITIES, DIRECT AND INDIRECT EFFECTS - ALTERNATIVE 2 (NO HERBICIDE)

Under this alternative, approximately 45% percent or roughly 550,000 acres of the Custer National Forest is naturally susceptible or at high risk to weed invasion in the project area at a much higher rate than if treated under an integrated pest management approach which utilizes herbicides. All native plant community values are at a much higher risk of being de-valued under this alternative. This includes values such as wildlife habitat, ungulate forage, viewsheds for and recreational experience in wild and scenic rivers, wilderness and roadless areas, fire regimes, and ecosystem health and integrity.

The negative affects of weed species introduction have been well documented. A review of the many effects that invasive species impose on native plant and animal communities can be found in Sheley and Petroff (1999). In brief, exotic plant species can decrease plant diversity, structure and function in native plant communities by out competing native species for available resources. Exotics have also been known to displace rare plant species (Thompson *et al.*, 1987; Lesica and Shelly, 1996). Some invaders release secondary compounds or allelopathogens that can affect the establishment of native plant species. In addition, some believe that there are situations where the invasion of exotic species is second only to habitat destruction as the most important threat to biodiversity.

These changes in native species composition and structure can have severe impacts on wildlife populations by altering forage availability, reducing cover and eliminating breeding sites. These effects may be felt from invertebrates and soil microbes to the largest ungulate, which depend on native plants for forage.

Invasive weeds can decrease organic matter content and nutrient availability in soils and can increase soil erosion and infiltration. Some species can even increase the salinity of the soil.

Plant communities altered by invasion will not respond to historical disturbance regimes such as fire, insect and pathogens and wind and storm events as they once did. As noted earlier, we conducted a risk assessment on the Custer National Forest, which showed the vulnerability of lands subject to invasion of weeds. The analysis shows about 45% percent or 550,000 acres of the Forest at high risk to weed

infestations. This is a significant portion of the land base. Furthermore, this acreage is not distributed evenly among the vegetation types. The higher elevation moist forest types are the least vulnerable to invasion, yet every acre of the low elevation non-forested communities is at risk. Although there are less acres of non-forest communities than forested, they comprise some of the more unique, species rich communities next to riparian and wetlands. Once converted, these habitats may never be restored to their original condition.

This is not to say that the forest types would not be at significant risk as well. Early successional stages of forest community, those that are most vulnerable to invasion, could be altered to where early forest succession could be impacted. Tree seedlings may have difficulty becoming established, which in turn may alter the future composition and vegetative structure of the forest. These changes in early and mid-serial vegetative structure also affect the frequency and intensity of nature disturbance processes, such as fire and insect infestations.

With Alternative 2 there will be an increase of weed spread, and the consequences described above will occur on the lands identified at risk.

NATIVE PLANT COMMUNITIES, DIRECT AND INDIRECT EFFECTS - ALTERNATIVE 3 (NO CHANGE FROM CURRENT MANAGEMENT)

Direct and indirect effects of this alternative are similar to Alternative 1 for the previously approved for treatment. The primary difference is all herbicide treatments would be restricted to ground based application. No aerial application of herbicide would be allowed. No herbicide treatment would occur in the AB Wilderness Area. In addition, the only herbicides that would be available for use would be picloram, 2, 4-D, dicamba, and glyphosate. Restricting the use of herbicides would eliminate the option of rotating herbicides due to one of the two options being non-selective.

This alternative would impact fewer native plant species or communities by the application of herbicides. This is because aerial herbicide application would not be allowed. The number of acres that can be treated by ground-based application is limited in extent, due to terrain, personnel, and time constrains. Impacts to native plant communities will come more from the continued spread of weed species than the loss of non-target plants to herbicides. Relatively speaking, this alternative protects the native plant communities better that Alternative 2 but not as good as Alternative 1.

NATIVE PLANT COMMUNITIES, CUMULATIVE EFFECTS

In addition to the native species that would possibly be impacted under Alternatives 1 and 3, other ongoing actions such as timber harvest, grazing, recreational use, mining and harvest of alternative forest products would also kill native plants. Although non-target plants will be affected from the use of herbicides, there is far greater potential loss of these native species and their habitats if nothing is done

With Alternatives 2 and 3 the trend of increasing infestations on the Custer National Forest are likely to also occur on adjacent private lands used for agriculture, lawns, and commercially developed. These alternatives would compound this problem by making greater acreage on public land available for invasion. Although most infestations do not originate on the Custer National Forest, there are cases where invasions originate on Forest lands and could potentially move out to invade private lands. In many cases, if the Forest Service fails to actively treat weeds then adjacent landowners will do the same.

The same trends of increasing infestation that we expect to occur on CNF lands are even more likely to occur in adjacent private lands. Much more so than public lands, private lands are often converted to agriculture, lawns, golf courses, grazed, pastured, and developed commercially. These are generally the types of sites where invader species are most successful. The no-action alternative would compound this problem by making greater acreage available for invasion. Although most infestations originate from off the CNF and move onto Forest lands, there are cases where invasion originates on Forest lands and could potentially move out to invade private lands.

It is anticipated that there will be new areas disturbed and at risk from weed invasion as a result of fire, and future timber harvest activities on the CNF. The CNF Forest Plan allows for an annual timber harvest of about 3 million board feet of timber. In recent years approximately 3 million board feet have been harvested. It is impossible to reasonably predict future timber harvest levels, but levels would likely be at or less than the allowable sale quantity. Newly harvested areas would be expected to be at some risk for new weed infestation, although the prevention features of this alternative as described in Chapter 2 would reduce the risk. Some of the new harvest areas would be in those vegetation types that are at low risk to weed invasion.

As time passes, acreage harvested since the 1970s will become less susceptible to weed invasion as closed canopy conditions develop. Most weeds found on the CNF do not survive well in closed canopy conditions; with the exception of those on the more open Douglas fir and Ponderosa Pine cover types.

Fewer acres will likely be at risk as a result of post-timber harvest activities in future years. Silvicultural post-harvest treatments used today and predicted for the near future expose far less bare soil than in the past, creating less ground disturbance susceptible to weed invasion.

Travel and recreation are likely to increase in the surrounding lands, which will likely increase the potential for invader weeds to spread both on and off Forest.

HUMAN HEALTH

This issue addresses the concern that weed control may have a detrimental impact on human health. More specifically, the impacts that herbicides (both ground and aerial spraying), mechanical control (i.e. mowing, hand or tool grubbing), seeding, biological, grazing, and burning may have on human health.

FACTORS AFFECTING HAZARDS ASSOCIATED WITH HERBICIDE

Method of Application

How herbicides are applied can have a direct impact on the potential for human health effects. According to the SERA (2003-2004) herbicide risk assessments herbicides applicators are at a higher risk than the general public from herbicide use. Risks associated with backpack, boom, and aerial application of herbicides were estimated to be the highest, due to workers receiving repeated exposures that may remain on the worker's skin for an extended time period.

Length of Exposure

The magnitude of a dose that is hazardous to health depends on whether a single dose is given all at once (acute exposure), multiple doses are given over longer periods (chronic exposure), or regularly repeated doses or exposures over periods ranging form several days to months (sub-chronic). The EPA develops reference doses, which are an estimate of a daily dose over a 70-year life span that a human can receive without an appreciable risk of deleterious effects (US EPA, 1989). Reference doses include a "safety factor" where the No Observed Adverse Effect Level (NOAEL) is divided by a factor, usually 100, to account for uncertainty and hypersensitive individuals. The 100-value is derived by including a safety margin of 10 for extrapolating study results from mammals to humans, and an additional safety factor of 10 for variation in population response to a particular compound.

The reference dose is a conservative threshold of toxicity relative to this analysis because it assumes daily exposure over a 70-year life span. Actual worker exposure for herbicide treatments in this project would typically be between 20 to 80 days each year for substantially less than 70 years. The reference dose is also calculated from the NOAEL, assuming humans are 100 times more sensitive than animals to the chemical tests.

Route of Exposure

Substances tested for acute toxicity are usually administered by pumping a chemical down a tube into an animal's stomach. From this route of exposure, an oral LD_{50} (lethal dose that kills 50 percent of a test population, measured in one milligram of herbicide per kilogram of animal weight) can be estimated. Exposure during chronic testing usually involves placing the chemical in the animal's food, and then measuring the amount of food eaten during each 24-hour period (US EPA, 1996a, b).

Test substances are also applied to the shaved skin of an animal to estimate a dermal $LD_{50.}$ About 10 percent of the animal's body surface is exposed to a chemical covered by a patch for 24 hours. In acute exposure studies, whether by oral or dermal routes, animals are monitored for range of adverse responses for 14 days following dosing (US EPA, 1996c).

Skin acts as a protective barrier to limit and slow down movement of a chemical into the body. Studies of pesticides applied to the skin of humans indicate that for many people, only about 10 percent or less passes into the blood. In contrast, adsorption of chemicals from the small intestine is quicker and more complete than from the skin (Ross et al., 2000).

Required personal protective equipment used by workers during herbicide application (gloves, waterproof boots, long sleeved shirts and pants) is designed to reduce exposure to sensitive areas on the body. Use of personal protective equipment as required by the Forest Service job hazard analysis would protect worker health.

Herbicide Toxicity – Risk Assessment

Pesticides are not risk-free. The reason EPA allows the use of products with the potential to cause toxicity is that, "when used according to label instructions"; the risks of the pesticide are outweighed by the benefits. Reading and following instructions on labels is the best way to insure personal safety.

The role of risk assessment is to determine if a pesticide is safe for users and the general population when handled and used as prescribed by its label. If not clearly safe, then the process also addresses the question as to whether changes can be made to meet the standards for safety.

The core risk assessment process comprises of the following steps:

- • Hazard identification and Dose-response assessment
- • Exposure assessment
- • Risk characterization

Hazard Identification and Dose-Response

Hazard identification requires a clear understanding of the chemical's toxic properties, particularly the adverse effects seen after conducting both short- (acute) and long-term (chronic) studies in laboratory animals per EPA standards. Well conducted multi-level feeding studies disclose if, and at what level, changes will occur in each organ of each test species and the nature of any change.

The dose-response assessment is the step that establishes the pattern of affects demonstrated by a pesticide when administered at different dose levels. In acute studies several dose levels are administered and lethality and other effects are monitored. In contrast, among the three or four feeding levels given in chronic studies the highest level(s) must cause clear adverse affects, but not death. Regulators require testing at this level in studies to evaluate carcinogenicity.

The highest pesticide dose that does not cause any observable harm or side effects to experimental animals is known as the No Observable Effect Level (NOEL). The NOEL is typically divided by a safety factor of 100 to l000 to obtain what EPA calls the Reference Dose (RfD). The safety factor is designed to protect sensitive portions of the population and to correct for genetic or species differences due to the extrapolation to humans from animal studies. The RfD is the toxicity level normally used to estimate a level of exposure at or below which no adverse effect is expected to occur even if the agent is ingested daily over an entire lifetime.

Acute toxicity can be a function of the amount of toxicant received, the route of administration, and the type of animal tested. Acute reactions tested include: oral, dermal, and inhalation toxicity; acute delayed neurotoxicity; eye and dermal irritation; and dermal allergic sensitization. Table 4 - 3 identifies the toxicity categories used by the EPA for various types of harmful, acute reactions. Table 4 - 4 displays acute reactions, of the proposed herbicides, in terms of a Signal Word, which is identified in Table 4 - 3.

TABLE 4 - 3. TOXICITY CATEGORIES FOR HARMFUL, ACUTE REACTIONS

Toxicity Category	Signal Word	Oral (mg/kg)	Dermal (mg/kg)	Inhalation (mg/kg)	Eye Irritation	Skin Irritation
I	DANGER Poison	0-50	0-200	0-0.2	Corrosive: corneal opacity **not** reversible within 7 days.	Corrosive
II	WARNING	>50-500	>200-2000	>0.2-2.0	Corneal opacity reversible within 7 days; irritation persisting for 7 days	Sever irritation at 72 hours
III	CAUTION	>500-5000	>2000-20,000	>2.0-20	No Corneal opacity; irritation reversible within 7 days	Moderate irritation at 72 hours
IV	NONE	>5000	>20,000	>20	No Irritation	Mild irritation at 72 hours

TABLE 4 - 4. HUMAN HAZARDS BASED ON ACUTE TOXICITY CATEGORIES[2]

Herbicide	Acute Oral Toxicity	Acute Dermal Toxicity	Acute Inhalation	Primary Eye Irritation	Primary Skin Irritation
2,4-D Amine	Caution	Caution	Caution	Danger-Poison	Caution
2,4-D Ester	Caution	Caution	Caution	None	Caution
Aminopyralid	None	None	None	None	None
Clopyralid	Caution	Caution	Caution	Warning	None
Chlorsulfuron	None	Caution	Caution	Caution	None
Dicamba	Caution	None	None	Danger-Poison	None
Diuron	Caution	Caution	None	Caution	None
Glysophate	None	None	Caution	Warning	None
Hexazinone	Caution	None	None	Danger-Poison	None
Imazapic	None	Caution	None	None	Caution
Imazapyr	None	Caution	Caution	Caution	Caution
Metsulfuron Methyl	None	Caution	Caution	Warning	Caution
Picloram	Caution	Caution	None	Caution	None
Sulfometuron Methyl	Caution	Caution	Caution	None	None
Triclopyr	Caution	Caution	Caution	Caution/Danger	Caution

Chronic toxicity results from prolonged, repeated, or continuous exposure to a chemical, typically at levels lower than necessary to cause acute toxicity. It often demonstrates a delayed response. Public concerns toward herbicides generally focus on potential chronic toxicity. Sublethal poisoning or exposure may be expressed by any of the following: skin/eye irritation; nervous system disorders; reproduction system disorders; damage to other organ systems (liver, kidney, lungs, etc.); birth defects; mutations; and cancer.

The EPA evaluates carcinogenicity (cancer), teratology (birth defects), reproductive, and mutagenicity (gene mutation) study results of herbicide effects to animals during the herbicide registration and re-registration processes. The study data is used to make inferences relative to human health. From these studies, chronic toxicity of herbicides proposed for use on the Custer National Forest is summarized in Table 4-5.

[2] Forest Service by SERA 1999-2004 at http://www.fs.fed.us/foresthealth/pesticide.shtml, EXTOXNET at http://extoxnet.orst.edu/, Pesticide Information Profiles, Oregon State University, EPA 9/2003, and EPA, 2005.

TABLE 4 - 5. CHRONIC TOXICITY SUMMARY[3]

Herbicide Active Ingredient and Chronic Reference Dose	Potential Chronic Effects			
	Carcinogenic (Cancer)	**Teratogenic (Birth Defects)**	**Reproductive**	**Mutagenic (Gene Mutation)**
2, 4-D (Dichlorophenoxyacetic acid) Chronic RfD 0.01 mg/kg/day	EPA re-registration concluded that 2, 4–D is a Group D chemical which is not classifiable as to human carcinogenicity. (EPA Re-registration 2005)	Malformations are likely to occur only at doses that are fetotoxic or maternally toxic. 2,4-D is not teratogenic. (SERA Page 3-13 and EPA Re-registration 2005)	2,4-D may be subject to additional screening and/or testing to better characterize effects related to endocrine disruption. (EPA Re-registration 2005)	Based on the overall pattern of responses observed in both *in vitro* and *in vivo* genotoxicity tests, 2,4-D is not mutagenic. (EPA Re-registration 2005)
Aminopyralid Chronic RfD 0.5 mg/kg/day	Aminopyralid is classified as "not likely to be carcinogenic to humans" based on the lack of evidence for carcinogenicity in mice and rats. (EPA 8/10/2005)	There is no quantitative or qualitative evidence of increased susceptibility of developmental toxicity studies. (EPA 8/10/2005)	There is no quantitative or qualitative evidence of increased susceptibility following pre-post-natal exposure. (EPA 8/10/2005)	There is no quantitative or qualitative evidence of increased susceptibility following pre- /post-natal exposure. (EPA 8/10/2005)
Chlorsulfuron Chronic RfD 0.02 mg/kg/day	No evidence of carcinogenic activity was found in any of the chronic toxicity studies conducted on chlorsulfuron. (SERA Page 3-7)	Chlorsulfuron is not teratogenic, but is embryo toxic at high exposure levels. (SERA Page 3-6)	Does not appear to have significant adverse effects on reproductive function. (SERA Page 3-6)	Not mutagenic, either with or without metabolic activation. (SERA Page 3-7)
Clopyralid Methyl Chronic RfD 0.15 mg/kg/day	Studies in rats, mice and dogs revealed no evidence of carcinogenic activity has been detected. (SERA Page 3-6)	At doses that cause no signs of maternal toxicity (i.e., doses below about 100 mg/kg/day) no teratogenic effects are apparent. (SERA Page 3-6)	At doses that cause no signs of maternal toxicity (i.e., doses below about 100 mg/kg/day) no reproductive effects are apparent. (SERA Page 3-6)	Clopyralid was found to be is inactive in three different standard bioassays of mutagenicity. (SERA Page 3-6)
Dicamba Chronic RfD 0.03 mg/kg/day	There are no epidemiology studies or case reports that demonstrate or suggest that exposure to dicamba leads to cancer in humans. (SERA Page 3-9)	Pregnant rats and rabbits indicated no evidence of birth defects. (SERA Page 3-9)	Three multi-generational studies of rats produced no adverse effects on reproduction with doses up to 25 mg/kg/day. (SERA Page 3-9)	Negative in tests for genetic damage. (SERA Page 3-10)
Diuron Chronic RfD 0.003 mg/kg/day	The Carcinogenicity Peer Review Committee (CPRC) characterized diuron as a "known/likely" human carcinogen, based on urinary bladder carcinomas in rats. (EPA Re-registration EPA 9/30/2003 p. 11)	There is no indication of increased susceptibility to young exposed to diuron in the available studies. In the developmental toxicity study in rabbits, there were no developmental effects at the highest dose tested. (EPA Re-registration EPA 9/30/2003 p. 11)	It is unlikely that diuron will cause reproductive effects in humans at expected levels of exposure. (EPA Re-registration EPA 9/30/2003 p. 12)	Diuron is not mutagenic. Tests have shown that diuron does not produce mutations in animal cells or in bacterial cells. (EPA Re-registration EPA 9/30/2003 p. 11)
Glysophate Chronic RfD 2mg/kg/day	EPA classified as evidence of non-carcinogenicity for humans. (SERA Page 3-16)	Pregnant rats (up to 3,500 mg/kg/day) and rabbits (up to 350 mg/kg/day) indicated no evidence of birth defects. (SERA Page 3-13)	Multi-generational studies of rats, no adverse effects on fertility or reproduction with doses up to 30 mg/kg/day. (SERA Page 3-13)	No in vivo studies using mammalian species or mammalian cell lines have reported mutagenic activity. (SERA Page 3-17)
Hexazinone	Study with rats found no tumors up to 125 mg/kg (highest dose	Pregnant rat study no evidence of birth defects at doses up to 100	Three-generations of rat study found no evidence of reproductive effects, except	Three of four tests were negative. EPA concluded not a mutagen. (SERA Page

[3] Page cites are to the individual herbicide reports completed for the Forest Service by SERA 1999, 2003-2004. Each report is located at http://www.fs.fed.us/foresthealth/pesticide.shtml. The Human Health Risk Assessment portion of each herbicide report is located in the Project Record. Other citations come from EPA findings 2003 and 2005.

Herbicide Active Ingredient and Chronic Reference Dose	Potential Chronic Effects			
	Carcinogenic (Cancer)	Teratogenic (Birth Defects)	Reproductive	Mutagenic (Gene Mutation)
Chronic RfD 0.05 mg/kg/day	tested). EPA will re-evaluate mouse study. (SERA Page 3-4 to 3-5)	mg/kg/day; higher doses did have effects. EPA concludes not teratogen. (SERA Page 3-3)	decreased weight of pups at highest dose (125 mg/kg). EPA requested further information. (SERA Page 3-3)	3-3)
Imazapic RfD 0.05 mg/kg/day	EPA classified as not likely to be carcinogenic for humans. (SERA Page 3-5)	Two rat studies showed no signs of teratogenicity at the highest dose tested (i.e., 1000 mg/kg/day). (SERA Page 3-4)	Multi-generational rat study showed no indication of any effect on reproductive performance. (SERA Page 3-5)	Four assays produced negative results for mutagenicity. (SERA Page 3-5)
Imazapyr Chronic RfD 2.5 mg/kg/day	EPA has categorized imazapyr as Class Evidence of non-carcinogenicity. (SERA Page 3-7)	Five studies show imazapyr does not cause adverse developmental effects. (SERA Page 3-6)	Five studies reveal that imazapyr does not cause adverse reproductive effects. (SERA Page 3-6)	Three studies have shown negative potential for potential mutagenic activity. (SERA Page 3-7)
Metsulfuron Methyl Chronic RfD 0.25 mg/kg/day	EPA concluded that: "Metsulfuron methyl was not oncogenic in the chronic rat and mouse bioassays. (SERA Page 3-7)	EPA –"The results of a series of studies indicated that there were no teratogenic hazards associated with the use of metsulfuron methyl. (SERA Page 3-6)	EPA-"The results of a series of studies indicated that there were no reproductive, hazards associated with the use of metsulfuron methyl. (SERA Page 3-6)	EPA concluded that "Metsulfuron methyl was not mutagenic in the chronic rat and mouse bioassays. (SERA Page 3-7)
Picloram Chronic RfD 0.2 mg/kg/day	EPA has categorized picloram as Group E (no evidence of carcinogenicity) based on the lack of carcinogenic activity in rats and mice. (SERA Page 3-8)	Signs of kidney damage were noted at 1000 mg/kg/day. (SERA Page 3-7)	No effects on reproductive performance in studies with 298 to 1,000 mg/kg/day doses. (SERA Page 3-7)	EPA- in reviewing mutagenicity assays determined that "No compelling evidence of a mutagenic effect in relevant biological systems was uncovered". (SERA Page 3-7)
Sulfometuron Methyl Chronic RfD 0.02 mg/kg/day	Four studies find that exposure to sulfometuron poses no carcinogenic risk to humans. (SERA Page 3-8)	The No Observable Adverse Effect Level for teratogenic effects is 300 mg/kg/day. (SERA Page 3-7)	No adverse effects on reproductive parameters were observed in rats exposed to dietary sulfometuron methyl at dietary concentrations up to 5000 ppm. (SERA Page 3-8)	Four studies show no mutagenic activity. (SERA Page 3-8)
Triclopyr Chronic RfD 0.05 mg/kg/day	EPA classified as Group D chemical (not classifiable as to human carcinogenicity) because of marginal response in mice/rats, and the absence of additional support from structural analogs or genotoxicity. (SERA Page 3-9 & EPA Re-registration 1998)	Studies show that teratogenic effects occur only at doses that are maternally toxic. At doses which do not cause maternal toxicity, there is not apparent concern for teratogenic effects. (SERA Page 3-8)	Studies show that reproductive effects occur only at doses that are maternally toxic. At doses which do not cause maternal toxicity, there is not apparent concern for teratogenic effects. (SERA Page 3-8)	Negative in several tests, but weakly positive in a test in rats. (SERA Page 3-10)

It is important to note that there is much uncertainty and controversy regarding chronic toxicity. For example, the risk analysis completed by EPA makes four primary assumptions: that a carcinogenic substance in animals will have similar potency in humans; that there is a linear relations between dose and carcinogenic response; that the slope of the dose response relationship at low doses can be derived from data at high doses; and it treats all carcinogens, regardless of the mechanism of action, in the same manner (Wilson, 2005). While these assumptions may be valid, they are not proven, and they show some of the complexity associated with risk analysis for chronic toxicity.

There is considerable information on sub-chronic and chronic effects due to exposure to herbicides in controlled animal studies. The information provided in Table 4 - 5 suggests that most the herbicides proposed for use by the Custer National Forest would not result in carcinogenic, mutagenic, teratogenic, neurological or reproductive effects based on anticipated exposure levels to worker and the public when applied under label direction. Table 4- 5, however, indicates that there is some possible concern associated with diuron related to potential carcinogenic effects. However, The EPA addressed these concerns during re-registration through the use of risk protection measures that were added to label direction. It was determined that diuron would not pose unreasonable risk of adverse effects to humans or the environment when used in accordance with labeling required by the 2003 EPA re-registration decision.

Exposure Assessment

Exposure assessment includes an estimate of people's potential exposure to a chemical at work, at home, or in their diets and covers periods from acute to lifetime exposures. Levels of exposure are determined by measuring pesticide residues in food, water, ambient air and occupational exposure to applicators and workers. The results of animal metabolism, absorption and elimination studies also are helpful in establishing human exposure levels to pesticides.

A Hazard Quotient (HQ) is the ratio between the estimated dose (the amount of herbicide received from a particular exposure scenario) and the Reference Dose (RfD). A RfD is a dose level determined to be safe by the EPA over a lifetime of daily exposure. When a predicted dose is less than the RfD, then the HQ (estimated dose/RfD) is less than 1, and toxic effects are unlikely for that specific herbicide application. A comparison of herbicide toxicity hazard quotients for workers and the general public, at typical levels of exposure, are shown in Tables 4 - 6 and 4 - 7. Hazard Quotients exceeding 1 are in bold text with a shadowed background.

TABLE 4 - 6. HERBICIDE TOXICITY HAZARD QUOTIENTS FOR WORKERS[4]

HERBICIDE	REFERENCE DOSE (RfD)[5] (mg/kg/day)	ACUTE / ACCIDENTAL EXPOSURE[6]	CHRONIC/ LONG TERM EXPOSURE		
	Acute/Chronic	Hands, Gloves, Spills –Hands & Legs	Ground Spray (Backpack)	Broadcast Spray (Boom Spray)	Aerial Application
2, 4-D (Dichlorophenoxyacetic acid)	.01/.01	.1725	**1.3125**	**2.24**	**1.47**
Chlorsulfuron	.25.02	.00002	.04	.06	.04
Clopyralid	.75/.15	.0008	.03	.05	.03
Dicamba	0.1/.045	.0130	. 5833	.9956	
Glyphosate	2/2	.001	.01	.02	.01
Hexazinone	.05/.05	**5.29**	**3.2**	**6.048**	**3.2**
Imazapic	.5/.5	.1	.003	.001	.003
Imazapyr	2.5/2.5	.001	.002	.004	.0003
Metsulfuron methyl	.25/.25	.000008	.002	.003	.002
Picloram	.2/.2	.005	.02	.04	.03
Sulfometuron methyl	.87/02	.00003	.03	.05	.03
Triclopyr	1/.05	.02	.3	.4	.3

Aminopryalid and diuron acute and chronic worker exposure hazards were not shown as part of the above table and will be described narratively below:

Aminopyralid[7]: Based on aminopyralid's low toxicity profile, an acute Reference Dose (RfD) for the general population or any of the population sub-groups was not required by EPA.

Based on labeled uses, the occupational exposure is expected to be short- to intermediate-term and no long-term exposure is expected. The application of aminopyralid to control weeds in wheat, rangeland, pastures, non-cropland areas and natural recreation areas is recommended by using broadcast treatment with ground and aerial equipment on wheat and also hand-spray and spot treatments for all other uses.

Based on the available toxicological information, dermal exposures do not result in any adverse systemic effect; therefore, dermal exposures were not included into the estimation of occupational risk to workers. Short- and intermediate-term oral and inhalation exposures are being regulated based on the effects seen in the developmental rabbit toxicity study, which showed a NOAEL of 104 mg/kg/day.

The highest potential exposure was estimated to Mixer-Loaders working on aerial applications of 0.11 lb ae/A, for up to 1200 acres applied per day. The corresponding MOE is 40,000, greatly above the acceptable limit (MOE = 100) (EPA, 8/10/2005 Factsheet).

Diuron[8]: Occupational workers can be exposed to a pesticide through mixing, loading, and/or applying a pesticide, or re-entering treated sites. Occupational handlers of diuron include: workers in right-of-way areas or industrial sites, workers in agricultural environments, workers applying paints or stains, workers in ornamental fish and catfish production and workers applying diuron to ornamental plants and trees in nurseries.

According to EPA re-registration of diuron, it is not acutely toxic. No adverse effects attributed to a single exposure were identified in any available study.

---

[4] Information for Table 4-6 was taken from SERA(2003-2004) Risk Assessment herbicide worksheets located on the world wide web at http://www.fs.fed.us/foresthealth/pesticide/risk.shtml. Copies of the relevant worksheets are located in the Project Record.

[5] RfDs are set by the EPA.

[6] [1]Typical acute exposure is modeled for four different situations i.e. immersion of hands for duration of one minute, contaminated gloves, spills on hands, and spills on lower leg. The last three are all for a duration of one hour. The value identified in the table is for the category with the highest hazard quotient of the four categories.

[7] EPA, 8/10/2005.

[8] EPA, 9/30/2003

In general, the EPA is concerned when occupational cancer risk estimates exceed 1 x 10-4. The EPA will seek ways to mitigate the risks, to the extent that it is practical and economically feasible, to lower the risks to 1 x 10-6 (one in a million) or less. Five of the assessed scenarios have cancer risks greater than 1 x 10-4 at the highest feasible level of mitigation (private farmer/commercial applicator, typical/max rate) and are of concern by EPA. Twenty-six of the scenarios have cancer risks between 1 x 10-4 and 1 x 10-6 at the highest feasible level of mitigation (private farmer/commercial applicator, typical/max rate).

For occupational cancer risks between 1x10-6 and 1x10-4, EPA carefully evaluates exposure scenarios to seek cost effective ways to reduce cancer risks to the greatest extent feasible, preferably to a risk of 1x10-6 or less. For the scenarios assessed during re-registration, EPA determined that the use of personal protective equipment (PPE) or engineering controls (e.g., closed mixing and loading systems) would further reduce exposure to handlers but for some scenarios, such as mixing/loading and applying with a backpack sprayer, and applying with a rights-of- way sprayer, engineering controls are not available. For other scenarios, such as applying granular formulations with a tractor-drawn spreader, some engineering controls may be available but they are not universally used for this type of application. The EPA encourages the use of engineering controls, in all settings where practical and feasible, and allows for handlers to reduce PPE when engineering controls are used. However, EPA concludes that the risk reduction potential of requiring engineering controls for additional scenarios would not be commensurate with the costs and difficulties associated with implementing the requirement. To address cancer risks to occupational handlers, the registrant has agreed to the several protection measures, which are necessary, reasonable, and cost-effective and are included on the new label.

The EPA re-registration diuron post-application cancer assessment assumes that a worker would contact residues on the day of application for ten or thirty days a year, every year for 35 years. Since it is unlikely that a post-application worker would contact the highest possible residue value for that length of time, this assessment is considered very conservative. Also, less than 5 acres of paved road right-of-way diuron treatment every 2-3 years is reasonably foreseeable under Alternative 1. This amount of treatment is extremely conservative compared to the EPA's exposed worker scenarios.

Post-application cancer risks for private growers were calculated at both the typical application rate and the maximum application rate for each crop grouping. As mentioned previously, the occupational cancer risk assessment is a conservative assessment; therefore, all cancer risks to private growers were less than 1 x 10-4 on the day of treatment and are not of concern to the EPA (EPA, 9/30/2003).

TABLE 4 - 7. HERBICIDE HAZARD QUOTIENTS FOR THE GENERAL PUBLIC AT TYPICAL LEVELS OF EXPOSURE

Type of Exposure	*	2,4-D	Chlorsulfuron	Clopyralid	Dicamba	Glyphosate	Hexazinone	Imazapic	Imazapyr	Metsulfuron methyl	Picloram	Sulfometuron methyl	Triclopyr
ACUTE / ACCIDENTAL EXPOSURE													
Direct spray, entire body	C	**2.6055**	.0003	.01	.1986	.02	**15.6076738**	.05.	.009	.0001	.004	.0004	.2
Direct spray, lower legs	W	.2618	.00003	.001	.0200	.002	**1.5679460**	.005	.0009	.00001	.0004	.00004	.5
Dermal, contaminated vegetation	W	.2988	.00008	.0007	.0171	.001	0.4586713	.001	.0005	.00002	.0006	.00002	.6
Contaminated fruit	W	**1.1760**	.003	.005	.2352	.004	**7.4640000**	.002	.002	.001`	.02	.0006	.06
Contaminated water, spill	C	**34.0935**	.02	.3	**9.7410**	.7	**81.8243008**	.2	.1	.02	.4	.03	.3
Contaminated water, stream	C	**1.1278**	.002	.0007	.0557	.002	**1.3533835**	.000008	.00003	.00002	.007	.000004	.007
Consumption of fish, general public	M	**10.2349**	.0007	.01	.2924	.008	**8.1878850**	.0008	.002	.00005	.01	.002	.0005
subsistence populations	M	**49.8787**	.003	.05	**1.4251**	.04	**39.9029840**	.004	.009	.0002	.06	.01	.002
CHRONIC/ LONG TERM EXPOSURE													
Contaminated fruit	W	.2609	.01	.01	.0778	.002.	**3.1407471**	.0002	.0008	.0006	.003	.004	.03
Consumption of water	M	.0057	.00005	.0005	.0036	.00003	0.0548571	.0000001	.0000005	.0000007	.00005	.000003	.02
Consumption of fish, general public	M	.0003	.0000004	.000002	.00002	.00000005	0.0011429	$6x10^{-11}$	$1x10^{-9}$	$2x10^{-9}$	.0000003	.00000005	.000006
subsistence populations	M	.0023	.000003	.00002	.00014	.0000004	0.0092571	$5x10^{-10}$	.00000001	.00000002	.000002	.0000004	.00004

*C=child, W=woman, M=man

Aminopryalid and diuron acute and chronic exposure assessments to the general public were not shown as part of the above table and will be described narratively below:

Aminopyralid[9]: Based on aminopyralid's low toxicity, an acute Reference Dose (RfD) for the general population is not required.

The chronic RfD for aminopyralid is 0.5 mg/kg/day. This value is based on the NOAEL of 50 mg/kg/day in the rat combined chronic toxicity/carcinogenicity study with a 100-fold uncertainty factor to account for interspecies extrapolation (10X) and intraspecies variability (10X). An additional safety factor to protect infants and children is not required, due to the toxicity properties of the material and the conservative nature of the exposure estimates. A chronic exposure analysis was conducted using the tolerance levels for wheat grain and meat commodities and assuming 100% of crops treated with aminopyralid. The estimated exposures to US-population and relevant sensitive sub-population groups were all at least 3 orders of magnitude below the RfD (< 1% RfD).

There are no requested uses for aminopyralid that are considered residential and neither handler nor post-application residential exposures from uses around homes are expected to occur. However, the use on campgrounds and other recreation areas to control vegetation has the potential to result in short-term post-application incidental oral exposures for infants and children via hand-to mouth transfer of residues and ingestion of aminopyralid-contaminated grass and soil. For children with a 15-kg body weight exposed via the hand-to-mouth route, the potential MOE was 150,000. Therefore, post-application exposure via inhalation is not expected to occur.

The source of human exposure results from dietary exposure from food and drinking water, and short term incidental oral exposure, a short term oral exposure of children to treated campgrounds. Aggregating these exposure estimates gives a combined potential level of 0.0033mg/kg/day, for the highest exposed group, children 1-2 years of age. The margin of exposure (MOE) associated with this Tier I exposure estimate is 32,000, greatly above the acceptable limit (MOE = 100). EPA thus concludes that there is reasonable certainty that no harm will come from aggregate exposure to aminopyralid residues (EPA, 8/10/05 Factsheet).

The EPA considered the available data on the risks associated with the proposed use of Aminopyralid and the Triisopropanolammonium salt of Aminopyralid, and information on social, economic, and environmental benefits to be derived from such use. Specifically, the EPA considered the nature and its pattern of use, application methods and rates, and level and extent of potential exposure. Based on these reviews, the EPA was able to make basic health and safety determinations which show that use of Aminopyralid and its Triisopropanolammonium salt during the period of conditional registration will not cause any unreasonable adverse effect on the environment, and that use of the pesticide is, in the public interest. EPA determined that the use of aminopyralid is of significance to the user community, and appropriate labeling, use directions, and other measures have been taken to ensure that use of the pesticides will not result in unreasonable adverse effects to man and the environment (EPA, 11/23/2005 Registration).

Diuron[10]: Diuron is not acutely toxic. No adverse effects attributed to a single exposure were identified in any available study. Therefore, EPA did not conduct acute dietary risk assessment.

Based on labeled uses, no intermediate- or long-term residential handlers, or substantial post-application exposures of any duration, are expected. The EPA also concluded that chronic risk of diuron in drinking water is not a concern.

Although estimated exposure to diuron residues in food alone results in a cancer risk estimate of 1.68 x 10-6 for the general population, the EPA believes that this estimate is not of concern based on several protective assumptions in the assessment. The estimates of exposure from food are based largely on field trial data conducted at the maximum application rates (EPA, 9/30/2003 RED, p. 34).

---

[9] EPA, 11/23/2005 Registration and 2006 Lolo NF Discussion Points for Aminopyralid.
[10] EPA, 9/30/2003 RED

Risk Characterization

Risk characterization is the process of bringing the hazard identification and exposure assessment results together and determining if probable actual exposures will be safe to individuals who are likely to come into contact with the pesticide in normal use. In the U.S., the EPA calculates a series of safety factors for potentially exposed populations (e.g.- applicators, users, various segments of the general public including children) and will express the result as a safety factor. For example, if a level determined to be safe to a human is 0.l mg/kg of body weight and the analysis used to characterize the risk shows the actual exposure as 0.0002 mg/kg then a safety factor of 400 would result.

The process is quite different if the product being evaluated has demonstrated evidence of being a rodent carcinogen. In this case, though complex, the EPA process is summarized by stating that when assessing risk to humans of potentially carcinogenic products very conservative mathematic models are applied and safety factors are calculated. Because of the inherent uncertainty the safety factors that are calculated always err on the side of human safety.

An additional step, risk management, comes into play when results of risk characterization do not demonstrate adequate safety margins for the product as it is intended for use. In this step alternatives for changing the scope or manner of use and/or protection measures during product use are considered. Risk management relies partly on science, but also considers social, economic and legal parameters before a policy decision is made. A product may not be sanctioned for any use by EPA unless sufficient changes to ensure safety are identified and put in place.

Tables 4 - 6 and 4 - 7 indicate that most of the herbicides included in this analysis do not pose acute (short- term) or chronic (long-term) health risks to workers or the general public, assuming label directions are followed and personnel protective equipment is utilized. However, four herbicides 2, 4-D, dicamba, diuron, and hexazinone models show possibility of chronic effects to workers and acute effects to the general public. Chronic exposure to workers is related to ground (backpack and boom sprayers) and aerial application. Acute exposure to the public is associated with consumption of contained water and fish, and direct application to the entire body. Further risk characterization of these four herbicides follows below.

2, 4-D[11]

Worker Effects: The hazard quotients in both Tables 4 - 6 and 4 - 7 are based on the RfD of 0.01 mg/kg/day, which is derived from EPA. A RfD is an estimate of daily exposure (mg/kg/day) to the human population that is likely to be without risk of deleterious effects during a lifetime. Table 4 - 6 indicates a possible concern involving chronic exposure to 2,4-D for workers involving ground and aerial application. Information in Table 4-7 indicates a concern for the acute exposure of the public through consumption of contaminated water, fruit or fish or a dose covering an entirely naked body.

As discussed on page 3-55 of the SERA (1999) risk assessment for 2,4-D there is no evidence that overt signs of toxicity are plausible at exposures to dose levels less than 1 mg/kg/day of 2,4-D. This assessment is supported by the categorical regression analysis of the animal toxicity data on 2, 4-D. Thus, overt signs of toxicity are not expected to occur in workers involved in ground or aerial applications of 2, 4-D for which central (typical) estimates of the absorbed dose range from 0.013 to 0.022 mg/kg/day. This assessment is consistent with data regarding human experience with the use of 2, 4-D. Even at the upper limits of exposure (i.e., 0.08-0.15 mg/kg/day) there are not likely to be overt signs of toxicity. For workers involved in ground or aerial applications of 2,4-D all of the exposure assessments are based on an application rate of 1 lb a.e. /acre. Nonetheless, even at the highest anticipated application rate of 2 lbs a.e./acre, no overt signs of toxicity would be expected.

The 2, 4-D SERA (1999) risk assessment on page 3-57 states that "the best interpretation of the somewhat complex risk characterization for workers is that 2, 4-D can be applied safely if thorough and effective methods are used to protect workers and minimize exposure. If effective measures of hygiene

---

[11] SERA (1999) 2, 4-D Risk Assessment pages 3-55, 57, 58, 59, and 3-60.

are not employed, occupational exposure to 2, 4-D could result in adverse but probably not overtly toxic effects.

General Public: Like the worker exposure scenarios, some accidental public exposures are at doses that substantially exceed the RfD (i.e., direct spray, consumption of contaminated water, fish, or fruit shortly after application). These exposures, however, would be relatively short term. In addition many of the exposure scenarios associated with these higher levels of exposure are dominated by *arbitrary uncertainty*. In other words, the amount of exposure is dependent on the magnitude of a spill or some other accidental event. These arbitrary assessments are included in the risk assessment to illustrate the potential consequences of such accidents but the likelihood of such event occurring is probably very low (SERA, 1999, p. 3-57, 58, 59).

The exposures associated with the longer-term consumption of contaminated water are much more plausible and based on modest modeling extrapolations from monitoring studies. Although 2, 4-D is not a highly persistent chemical in water, it is persistent enough that it might contaminate groundwater and surface waters. As illustrated in Table 4-7, however, the plausible levels of longer term (chronic) exposures—based on conservative assumptions—are substantially below a level a concern (SERA, 1999, p. 359).

The SERA (1999) risk assessment analyses of the effects of consuming contaminated vegetation, at the modeled doses are some what conflicted. On the one hand it states that consumption of contaminated fruits may lead to covert health effects. On the other hand the plausibility of the scenario for the longer-term consumption of contaminated vegetation is questionable. First, 2, 4-D is a herbicide. If it is applied at a rate that will effectively kill target vegetation, consumable vegetation is also likely to be damaged to the point that it will not be available for consumption over prolonged periods. Although short-term consumption may occur after an unintentional direct spray, longer-term consumption is unlikely.

The SERA (1999) Risk Assessment, on page 3-60, concludes that "The most reasonable verbal interpretation for these conflicting risk characterizations is that, except for accidental exposures or extremely atypical and perhaps implausible ambient exposures to 2,4-D in vegetation, the risk assessment suggests that the normal use of 2,4-D will not pose any identifiable risk to the general public. "

EPA 2005 Re-Registration Findings[12]: The 2005 EPA re-registration decision considers 2, 4-D dietary (food) risks are less than 100% of the Acute Population Adjusted Dose (aPAD) and Chronic Population Adjusted Dose (cPAD) for all population subgroups and are not of concern.

The EPA also concluded that both the surface water and ground water values are below the drinking water level of concern for acute and chronic exposure, and are not of concern.

An aggregate risk assessment looks at the combined risk from dietary exposure for those chemicals reviewed during the re-registration process, as well as exposures from non-occupational sources (i.e., residential uses). In the preliminary and revised EPA re-registration risk assessments, the estimated acute and short-term exposures exceeded EPA's level of concern. As a result, 2, 4-D registrants agreed to reduce the maximum application rate to turf and residential lawns from 2.0 pounds acid equivalent per acres to 1.5 per application.

Based on current use patterns, occupational handlers (mixers, loaders, and applicators) may be exposed to 2, 4-D during and after normal use. The EPA identified 18 handler scenarios resulting from mixing/loading and applying 2,4-D for crop and non-crop uses. With the exception of mixing/loading wettable powder, all of the short-term and intermediate-term margins of exposure exceed the target of 100 with baseline personal protective equipment (PPE) (i.e., long-sleeved shirt, long pants, shoes plus socks, no respirator) or single layer PPE (i.e., long-sleeved shirt, long pants, shoes plus socks, gloves, no respirator) and are not of concern to EPA. The margins of exposure for handling wettable powder are above 100 with required engineering controls (i.e. water soluble bags).

---

[12] EPA 6/30/2005

Dicamba

For long term chronic exposure there are no risks apparent to either workers or the public, at typical application rates. Dicamba may be irritating to the eyes and cause mild and transient skin irritation, which are likely to be the most common effects as a consequence of mishandling dicamba. These effects can be minimized or avoided by prudent industrial hygiene practices during the handling of dicamba.

The greatest risk of Dicamba appears to be associated with acute or accidental exposure of the public to contaminated water resulting from a spill. Keeping the public away from an accident scene which involved the contaminated of water, until time and dilution can render a spill harmless, is the most likely mitigation for this situation. Subsistence populations may also be at risk from consumption of contaminated water and fish. However, typical subsistence populations (individuals who consume fresh caught fish as a major source of food) do not occur in or near the project area.

EPA Re-Registration: Dicamba is scheduled for EPA re-registration by May of 2006. New findings may be available for disclosure during the Final EIS on this project.

Diuron[13]

EPA 2003 Re-Registration Findings: The EPA's Cancer Assessment Review Committee has classified diuron as "known/likely to be carcinogenic to humans." The lifetime dietary cancer risk estimate is 1.68x10-6 for diuron, representing a borderline exceedance. Generally, EPA is concerned when cancer risk estimates exceed the range of 1x10-6 or one in one million, although this negligible risk standard should not be viewed as a bright line (precision) standard. Residues used in the calculations are from field trials conducted at the highest application rates and from tolerance level residues from certain commodities. In addition, some processing data are still outstanding, which would enable further refinement to the risk assessment. Therefore, the exposure calculation is a conservative estimate and the EPA is not concerned with the dietary cancer risk from diuron use. Although the combined risk slightly exceeds 1 x 10-6, EPA believes that, given the weight of evidence, diuron cancer risk is not of concern. In addition, other risk protection measures outlined in the label will result in lower aggregate risks. (EPA 9/30/2003, p. 95)

EPA determined that the established uses for diuron, with amendments, and risk mitigations to be added to the label changes as specified in the 2003 re-registration decision, met safety standards that there is a reasonable certainty of no harm for the general population. In reaching this determination, EPA considered all available information on the toxicity, use practices, and scenarios, and the environmental behavior of diuron.

An aggregate assessment was conducted for exposures through food, drinking water, and residential uses. The EPA determined that the human health risks from these combined exposures are within acceptable levels. In other words, EPA has concluded that the tolerances for diuron meet safety standards. In reaching this determination, EPA considered the available information on the special sensitivity of infants and children, as well as the chronic and acute food exposure (EPA 9/30/2003).

EPA has determined that worker risks from exposure to diuron in loading, mixing, and application scenarios would be adequately mitigated through the use of the personal protective equipment (PPE) outlined by label:

For post-application risk mitigation, the restricted entry interval for diuron labels remain at 12-hours with the following early entry PPE required: coveralls over long sleeved shirt and long pants, waterproof gloves, chemical resistant footwear plus socks, protective eye wear and chemical resistant headgear for overhead exposures.

Acute risks from drinking water exposures are not of concern. For chronic drinking water risk, drinking water monitoring data were used to determine the estimated environmental concentrations in surface water. These monitoring data confirm that actual concentrations of diuron are substantially less than

[13] EPA 9/30/2003

previous model estimates. Monitoring data show concentrations substantially below the chronic Drinking Water Level of Comparison. Short-term residential exposures to diuron are not of concern. The EPA concluded that the potential cancer risk from residential use is negligible because of the low volume of diuron used in paint and the sporadic, short-term duration of homeowner exposures.

Hexazinone[14]

Hexazinone is of relatively low acute toxicity but is a severe eye irritant. It is not classifiable as to human carcinogencity and does not cause other toxic effects of concern. The dietary risk posed by hexazinone is expected to be minimal. Most tolerances were reassessed and other existing tolerances are considered protective until confirmatory data are available for EPA reassessment. Exposure to workers generally is not expected to pose undue risks, due to hexazinone's overall low acute toxicity. However, based on toxicity concerns regarding primary eye irritation, a 48-hour return entry interval is required under label. (EPA, Re-registration Decision, 9/1994).

The major hazard associated with the use of hexazinone will involve accidental or incidental ocular or respiratory tract exposure. Hexazinone is a severe eye irritant. In addition, respiratory tract irritation was noted in workers applying granular formulations of hexazinone that contained high levels of dust or fine particulates. For workers, the uncertainties in the characterization of risk are dominated by the very wide range of projected exposures. Over the range of plausible application rates, all worker groups may be exposed to hexazinone at levels that exceed the RfD. Although workers using a *belly grinder* may be exposed to much higher levels of hexazinone, compared with other worker groups, the basic characterizations of risks are similar for all worker groups. The effects that are most likely to be observed after exposure to hexazinone are irritation to the eyes, respiratory tract, and skin. In general, irritant effects on the eyes and respiratory tract are likely to be more severe than effects on the skin. Even under the most extreme exposure scenarios, frank systemic effects are not likely to be observed (SERA, pp. 3-31 to 3-32).

In some accidental and extreme exposure scenarios, members of the general public may be exposed to levels of hexazinone above the RfD but still far below the levels projected for workers. While any exposure above the RfD is considered unacceptable by definition, the exposure estimates for the general public are in a range where the occurrence and nature of potential toxic effects cannot be well characterized. For the general public, as for workers, no signs of frank systemic effects are anticipated after accidental exposure to hexazinone (EPA Re-Registration Decision, 9/1994).

EPA's regulatory conclusion is that the use of currently registered products containing hexazinone in accordance with approved labeling will not pose unreasonable risks or adverse effects to humans or the environment (EPA, 1994 RED Facts).

Synergistic Interactions

Concerns are occasionally raised about potential synergistic interactions of herbicides with other herbicides in the environment or when they are mixed during application (tank mixing). Synergism is a special type of interaction in which the combined impact of two or more herbicides is greater than the impact predicted by adding their individual effects. The Forest Service SERA and EPA Risk Assessments address the possibility of a variety of such interactions. These include the interactions of the active ingredients in an herbicide formulation with its inert ingredients, the interactions of these herbicides with other herbicides in the environment, and the cumulative impacts of spraying as proposed with other herbicide spraying to which the public might be exposed.

No one can guarantee the absence of a synergistic interaction between herbicides and /or other chemicals to which workers or the public might be exposed. Analysis of the infinite number of materials a person may ingest or be exposed to in combination with chemicals is outside the scope of this analysis. The following table shows information relative to synergistic effects.

[14] EPA, 9/1994

TABLE 4 - 8 CONNECTED ACTIONS – SYNERGISTIC EFFECTS

Herbicide	Brand Name	Connected Actions
2, 4-D[15]	2,4-D	Herbicide mixtures containing 2,4-D plus triclopyr, dicamba, picloram, or glyphosate are used in Forest Service programs. There is some information to suggest that repeated exposure to 2,4-D and other phenoxy herbicides may result in an increased rate of elimination. 2,4-D is commonly mixed with picloram. There is some indication that co-exposure to 2,4-D and picloram may induce effects not associated with exposure to 2,4-D alone.
Aminopyralid	Milestone	There is very little information available on the interaction of aminopyralid with other compounds.
Chlorsulfuron[16]	Glean	The manufacturers recommend that chlorsulfuron formulations be mixed with a non-ionic surfactant. According to the product label, Telar (chlorsulfuron) may be applied in combination with other herbicides, such as 2, 4-D or glyphosate. However, there are no animal data to assess whether chlorsulfuron will interact, either synergistically or antagonistically with 2,4-D or any other herbicide.
Clopyralid[17]	Transline,	Clopyralid may be applied in combination with other herbicides, particularly in combination with 2, 4-D or 2, 4-D and picloram. There are no data in the literature suggesting that clopyralid will interact, either synergistically or antagonistically with these or other compounds.
Dicamba[18]	Banvel, Vanquish	There is no substantial evidence that dicamba will interact with other compounds.
Diuron[19]	Diuron 4L, Karmex	An evaluation for a mixture with diuron and chlorsulfuron (a.i.'s in the herbicide Telar DF) was conducted in a diuron risk assessment (BLM, 2005). Data suggests that the addition of chlorsulfuron in a tank mix does not generally result in any additional risks than diuron alone; however, a slight increase in risks to typical terrestrial plant species may occur with the use of the tank mix.
Glyphosate[20]	Roundup®, Rodeo, Accord	There is very little information available on the interaction of glyphosate with other compounds.
Hexazinone[21]	Velpar	There is very little information available on the interaction of hexazinone with other compounds. Available data suggest that hexazinone may be metabolized by and may induce cytochrome P-450. Thus, it is plausible that the toxicity of hexazinone may be affected by and could affect the toxicity of many other agents. The nature of the potential effect (i.e., synergistic or antagonistic) would depend on the specific compound and perhaps the sequence of exposure.
Imazapic[22]	Plateau, Plateau DG	As discussed in Section 3.1.16, the manufacturer of imazapic has recommended tank mixtures of this herbicide with glyphosate. No data are available on the combined toxicity of these two herbicides. Studies have been conducted on mixtures of 2, 4-D and imazapic. While these combinations are more toxic than imazapic alone, there appears to be no basis for asserting that synergistic effects are likely because the toxic action is probably due to 2, 4-D alone.
Imazapyr	Arsenal, Chopper, Stalker	Imazapyr may be applied in combination with other herbicides. No data have been encountered in the literature that permits a characterization of the joint action of imazapyr (i.e., synergism, antagonism, or additivity) with most herbicides.
Metsulfuron Methyl[23]	Escort®	The manufacturers recommend that metsulfuron methyl formulations be mixed with a surfactant. There is no known published literature or information in the FIFRA files. According to the product label, Escort may be applied in combination with other herbicides. However, there are no animal data to suggest that metsulfuron methyl will interact, either synergistically or antagonistically with any other herbicide.
Picloram[24]	Tordon	A commercial formulation of picloram and 2,4-D, Tordon 202C, has been shown to inhibit immune response in mice.
Sulfometuron Methyl[25]	Oust XP	The manufacturers recommend that sulfometuron methyl formulations be mixed with a surfactant. There is no known published literature or information in the FIFRA files. According to the product label, Oust may be applied in combination with other herbicides. However, there are no animal data to suggest that sulfometuron methyl will interact, either synergistically or antagonistically with any other herbicide.
Triclopyr[26]	Garlon 4	There is very little information available on the interaction of triclopyr with other compounds.

[15] USFS, SERA 1999
[16] USFS, SERA 2004
[17] USFS, SERA 2004
[18] USFS, SERA 2004
[19] BLM, 2005
[20] USFS, SERA 2002
[21] USFS, SERA 1999
[22] USFS, SERA 2004
[23] USFS, SERA 2004
[24] USFS, SERA 2003
[25] USFS, SERA 2004

There is some uncertainty in the use of a mix because herbicides may not interact in an additive manner. Risk may be overestimated if the interaction is antagonistic, or risk may underestimate if the interaction is synergistic. In addition, other products may also be included in tank mixes and may contribute to the potential risk.

Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Section 3(c)5(C,D), EPA registers pesticides for use based on a determination that the product *"will perform its intended function without unreasonable adverse effects on the environment, and that when used in accordance with the widespread and commonly recognized practice, the product will not generally cause unreasonable adverse effects on the environment"*. The EPA is aware that tank mixes are part of the *"widespread and commonly recognized practice"* and has not required testing to assess their safety. Supporting the EPA's decision not to require testing are the following: years of experience in agriculture and vegetation management with tank mixing, the absence of a pattern of adverse or unexpected effects on the environment, and a growing body of scientific studies that suggest increased toxicity (synergism) of herbicide mixtures is a rare occurrence. In those rare cases where synergism has been demonstrated in laboratory studies, laboratory exposures were at levels that far exceed the potential exposure that would result from tank mixing for workers, bystanders or the consumer.

Given that the products are used as directed by the label and proper Personal Protective Equipment (PPE) is worn, adverse effects are not likely to occur. Labels for both tank mixed products should be thoroughly reviewed and mixtures with the least potential for negative effects should be selected. Use of the mix should be based on the most restrictive herbicide in the mixture. It should be noted that the herbicide label indicates if a herbicide can be mixed with other herbicides.

Impurities, Adjuvant and Inert Ingredients in Herbicide Formations

During commercial synthesis of some pesticides, by products can be produced and carry over into the product eventually formulated for sale. Occasionally byproducts or impurities are considered toxicologically hazardous, and their concentrations must be limited so that potential exposures do not exceed levels of concern.

For most of the herbicides in Table 4-9 there is little information in the published literature on manufacturing impurities in the herbicides. Nonetheless, virtually no chemical synthesis yields a totally pure product. To some extent, concern for impurities in technical grade herbicides is reduced by the fact that the existing toxicity studies on the herbicides were conducted with the technical grade product. Thus, if toxic impurities are present in the technical grade product, the toxic potential of the impurities are likely to be encompassed by the available toxicity studies on the technical grade product. Tables 4-4 and 4-5 provide information on the toxicity of the herbicides contained in Table 4-9.

Literature contains considerable information on the types of inert ingredients and adjuvant present in herbicides proposed for use by the Custer National Forest. Table 4-9 summarizes the information provided by the SERA (1999, 2003-2004) risk assessments for inert material, and adjuvants.

[26] USFS, SERA 2003

TABLE 4 - 9 SUMMARY OF IMPURITIES, INERT MATERIAL, AND ADJUVANTS

Herbicide	Brand Name	Impurities, Inert Materials and Adjuvants	Comment[27]
2, 4-D (Dichlorophenoxyacetic acid)	2,4-D Amine	monochlorophenoxyactetic acid , 2,6-dichlorophenoxyacetic acid , 2,4,6-trichlorophenoxyacetic acid, and bis(2,4-dichlorophenoxy)-acetic acid.	It is likely that the toxicity of the minor impurities is encompassed by the studies on the technical grade product. SERA, Page 3-30
Aminopyralid	Milestone	Trace amounts of CO2 and NH3.	No major degradates were identified. EPA, 2005
Chlorsulfuron	Glean	Confidential	None of the additives are classified by the U.S. EPA as toxic. SERA, Page 3-8
Clopyralid Methyl	Transline,	isopropyl alcohol, polyglycol, Polyglycol 26-2	U.S. EPA (2003) identifies ploygIycol 26-2 as List 3* inert. Other materials are food additives. SERA, Page 3-8,9
Dicamba	Banvel, Vanquish	Confidential	No apparently hazardous materials have been identified. SERA, Page 3-12.
Diuron	Diuron 4L, Karmex	Trace amounts of a manufacturing impurity, 3,3',4,4'-tetrachloroazobenzene, a.k.a. TCAB, which has been shown to be a cytochrome P450 enzyme inducer.	Chronic toxicity/carcinogenicity studies are not available for TCAB. However, since it is assumed that TCAB may have been present in all diuron toxicological test materials, including the test material for the chronic toxicity/carcinogenicity studies, the EPA believes that the risks from exposure to diuron (including carcinogenic potential) have not been underestimated. EPA 9/2003 p. 22
Glysophate	Roundup®, Rodeo, Accord, Roundup Pro	nitrosamine, N-nitroglyphosate (NNG), 1,4 Dioxane	The EPA concluded that the NNG content of glyphosate was not toxicologically significant. Page 3-25. Dioxane does not present unquie toxic effects and is likely to be encompassed by the available toxicity data for Roundup. SERA, Page 3-26
Hexazinone	Velpar	ethanol.	Ethanol is a strong eye irritant, and the presence of ethanol may contribute to the irritant effects of Velpar L. Based on the acute toxicity of hexazinone, no adverse effects are anticipated. SERA, Pages 3-8 to 3-10
Imazapic	Plateau, Plateau DG	Confidential	None of the additives are classified by the U.S. EPA as toxic. SERA, Page 3-7
Imazapyr	Arsenal, Chopper, Stalker	Confidential	Inerts and adjuvants have been disclosed to U.S. EPA. Page 3-9
Metsulfuron Methyl	Escort®	sodiumnaphthalene sulfonate-formaldehyde condensate	No plausible basis for asserting that the inerts are present in toxicological amounts. SERA, Page 3-9
Picloram[28]	Tordon	Hexachlorobenzene, Polyglycol 26-2	Based on the levels of contamination of technical grade picloram with hexachlorobenzene the contamination is not significant in terms of potential systemic toxic effects. Polyglycol is an EPA List 3 inert.. SERA, Pages 3-9,10
Sulfometuron Methyl	Oust XP	Confidential	None of the additives are classified by the U.S. EPA as toxic. SERA, Page 3-10
Triclopyr	Garlon 4	Ethanol, kerosene	The amount of ethanol is not toxicologically significant in terms of potential toxicity. Kerosene is classified by U.S. EPA as a List 3* Inert. SERA, Page 3-13

The SERA and EAP risk assessments, summarized above, indicate that the kind and amount of inert material, and adjuvants included in the different herbicides proposed for use would not likely result in

[27] Page cites are to the individual herbicide reports completed for the Forest Service by SERA (1999,2003-2004). Each report is located at http://www.fs.fed.us/foresthealth/pesticide.shtml. The Human Health Risk Assessment portion of each herbicide report is located in the Project Record.

[28] EPA List 3 – there is insufficient information to categorize this compound as either hazardous (Lists 1 or 2) or non-toxic (List 4).

adverse health effects to workers or the general public. The toxicity assessments (Tables 4 - 4, 4 - 5), which are thought to cover the impurities in the technical grade herbicides, also seem to indicate a lack of health concerns. This assumes that herbicide labels are followed and that correct personal protective equipment is available and used.

Dyes

The use of any agent (such as herbicides, dyes, surfactants, or other additives) may pose some level of human risk. The uses of dyes have beneficial consequences in that they can color vegetation, making it less likely for an individual to inadvertently or un-intentionally consume contaminated vegetation. The presence of a dye in herbicide formulations may also make it easier for workers to see when they have been contaminated and allow for prompt remedial action.

Not withstanding these potential benefits, the colorants or other components in the dyes may pose additional risks to humans and wildlife. The assessment of these risks (SERA, 1997) is limited by the proprietary nature of dye formulations. For most of the available dyes, neither the colorants nor adjuvants in the dye formulation are disclosed by the manufacturers. Unless the compound is classified as hazardous by the U.S. EPA, the manufacturer is not required to disclose its identity.

Significant technological advances have been made with respect to dyes available for pesticide applicators. Several water soluble dyes of low toxicity are available, and their use can provide an added level of safety for the workers and the public

Adjuvants / Surfactants

Surfactants are also commonly used in herbicide formulations. Surfactants are added to herbicides to improve herbicide mixing and the absorption or permeation of the herbicide into the plant. Like dyes and other inert ingredients, there is often limited information on the types of surfactants used and the toxicity of surfactants, especially since the industry considers the surfactant to play a key role in the effectiveness of the herbicide formulations. Most knowledge of surfactants is kept as proprietary information, and not disclosed. USFS (1997), which assessed the effects of surfactant formulations on the toxicity of glyphosate, reported that toxicity of glyphosate alone was about the same as the toxicity when mixed with surfactant and greater than the toxicity of the surfactant alone. Whether this same pattern would hold true of other herbicides having the same or different surfactants is unknown. If so, the toxicological studies performed on herbicide formulations (which contain the inert ingredients and surfactants) may accurately portray the toxicity and risks posed to humans by the surfactant.

What research there is show that for a surfactant to increase the absorption of another compound, the surfactant must affect the upper layer of the skin. Without some physical effect to the skin, there will be no change in absorption as compared to the other compound alone.

The studies discussed below indicate that in general non-ionic surfactants have less of an effect on the skin, and hence absorption, then anionic or cationic surfactants. Compound specific studies indicate that the alkylphenol ethoxylates generally have little or no effect on absorption of other compounds. In several studies, the addition of a surfactant actually decreased the absorption through the skin. It would appear that, given the data available here, there is little support for the contention that the addition of surfactants to herbicide mixtures would increase the absorption through the skin of these herbicides (Bakke 2002).

Surfactants, by their very nature, are intended to increase the effect of a pesticide by increasing the amount of pesticide that is in contact with the target (by reducing surface tension). This is not synergism, but more accurately is a reflection of increased dose of the herbicide active ingredient into the plant (Bakke 2002).

Although there is not much data in the technical literature, the references included in this paper indicate a lack of synergistic effects between surfactants and pesticides (Bakke 2002).

Adjuvant Hazards Assessment

Basic information concerning adjuvants commonly used with herbicides describes hazard information below and is used in conjunction with Forest Service national herbicide risk assessments (Bakke 2002).

Of the adjuvants discussed in the Bakke 2002 assessment, only two carry the Danger signal word [29] (Entry™ II and LI-700®), which is due to the potential effects to the eyes (severely irritating or corrosive). The bulk of the remainder carry the Caution signal word, while several carry the Warning signal word (again because of potential irritant effects to the skin or eyes). None of the adjuvants carry the poison symbol. All of the adjuvants in the assessment are no more than slightly toxic when ingested, inhaled, or absorbed through the skin.

None of the adjuvants contain ingredients found on U.S. EPA's inerts list 1 or 2. This is either based on the identified ingredients, or if these ingredients are not sufficiently identified, by information given by the manufacturers. The assessment of hazards for adjuvants is limited by the proprietary nature of the formulations. Unless the U.S. EPA classifies a compound in the formulation as hazardous, the manufacturer is not required to disclose its identity. At the current time, the disclosure of whether a material is hazardous is based primarily on acute toxicity.

Ammonium, or nitrogen, fertilizers are often added to herbicide mixes in range and row-crop agriculture situations, where the addition of fertilizer works to both enhance herbicidal effects as well as to stimulate the growth of desirable crop or forage plants. Ammonium fertilizers can function as utility adjuvants, because they help prevent the formation of precipitates in the tank mix or on the leaf surface. They also decrease surface tension, increase spreading of the herbicide on the leaf surface, neutralize ionic charges, and increase herbicide penetration into the leaf. Ammonium fertilizers are used primarily with broadleaf-specific herbicides (Tu et. al. 2003).

Ammonium fertilizers used as adjuvants include urea-ammonium nitrates (UAN), ammonium sulfates, ammonium nitrates and ammonium polyphosphates. Although their exact mode of action in herbicide control is unknown, they are often used to enhance the postemergence activity of weakly acidic herbicides, primarily by increasing herbicide absorption. The activity of ammonium fertilizers is strongly herbicide- and species-specific, and is probably dependent on several mechanisms.

Ammonium sulfates are also used to reduce antagonism by hard water ions in spray solutions. Iron, zinc, magnesium, sodium, potassium and calcium ions can react with certain herbicides (such as 2,4-D and glyphosate) to form precipitates or herbicide salts, decreasing the efficacy of those herbicides. Ammonium sulfate prevents the formation of the calcium salt of glyphosate and is recommended in most areas with hard water (Tu et. al. 2003).

Ammonium sulfate is EPA registered as a water conditioner adjuvant and as a herbicide. It can be used as an effective herbicide for tall larkspur control when used alone (see Chapter 3). It is anticipated that the use of this product as an herbicide would generally be through spot treatment of tall larkspur (less than 60 gross acres) in its' granular formulation.

Probable routes of human exposure to ammonium sulfate are inhalation, ingestion, and dermal contact. This product may irritate eyes and skin upon prolonged or repeated contact. There are no carcinogenaic, mutagenic, or teratogenic effects. There is no known effect from chronic exposure to this product. Acute oral toxicity (LD50) is 3000 mg/kg (Rat.) which correlates to very low toxicity for humans or animals. The product itself and its products of degradation are not toxic under normal conditions of use. It will release ammonium ions. Products of biodegradation are nitrogen oxides and sulfur oxides. This agent is a toxic hazard to fish and releases into watercourses and accidental spills are to be avoided. http://www.fertilizerworks.com/html/msds_granamm.html.

---

[29] Signal words are required on pesticide and registered adjuvant labels, and provide an overall view of the acute toxicity, or effects to eyes or skin, of the product. There are three signal words used by U.S. EPA, Danger, Warning, and Caution, to signify decreasing levels of this toxicity. In addition, the Danger signal word can be accompanied by the skull and crossbones symbol if the product is an acute poison.

The primary summary statement that can be made is that the more common risk factors for the use of adjuvants are through skin or eye exposure. Adjuvants all have various levels of irritancy associated with skin or eye exposure. This points out the need for good industrial hygiene practices while utilizing these products, especially when handling the concentrate, such as during mixing. The use of chemical resistant gloves and goggles, especially while mixing, should be observed.

UNCERTAINTY

With exception of accidental exposures or exposures under very conservative and somewhat implausible exposure scenarios, workers and the general public should not be exposed to a herbicide at concentrations that result in an adverse health effects. This conclusion is predicated on Forest Service employees and/or contractors wearing appropriate personal protection, applying herbicides in accordance with the label, and implementing the job hazard analysis program. By doing so, possible exposure by contact or through drift would result in potential dose below that determined to be safe by the EPA over a lifetime of daily exposure. It is also predicated on the finding, back by toxicological studies, that a person can be exposed to some amount of a contaminant and not have an adverse effect (i.e. the dose determines the effect).

All of the herbicides proposed for use by the Custer National Forest are registered for use by the EPA and the states of Montana and South Dakota. Registration of these herbicides and Federal regulations adopted to protect workers and the general public has required more scientific information and justification for use of herbicides. Nevertheless, there are many reports in the scientific literature that document associations between herbicide exposure and alterations of the immune system, autoimmune disorders, and increases in the probability of carcinogenesis. Felsot (2001), MCCHB (2001), Popp (1995), and Glover-Kerkvliet (1995) are just a few references that provide information on such effects. The body of literature on herbicide effects raises concerns about additive and synergistic effects of exposure to more than one herbicide, unstudied or unknown consequences of low level chronic exposures, toxicity of inert ingredients, by-products or contaminants of herbicides, and uncertainties about the health effects of sensitive populations. There is also the realization that it is difficult, if not impossible, for government or any scientific agency to fully evaluate a chemical and all the potential combinations of them to ensure that there would not be an adverse effect.

It would be inappropriate to suggest that use of herbicides to control noxious weeds is without risk to workers and the general public. If herbicides are used, there is the possibility of workers and general public exposure, no matter how many protection measures are implemented. All chemical exposure results in some level of health risk, the risk primarily being a function of the dose, or amount a person or organism is exposed to over a period of time.

It is equally inappropriate to conclude that any exposure, regardless of dose, would result in an effect. It is easy to find a report showing a health effect caused by the exposure to a herbicide or any other chemical. The toxicological studies are purposely done using high doses to demonstrate an effect. It is the herbicides that show effects at low levels of exposure or those levels anticipated when in use that should raise concern. With respect to this analysis, the potential dose received by the worker or the public does not approach the exposure levels shown to cause acute or chronic toxicity in the literature. Acute effects occur at doses thousands to tens of thousands of times higher than those estimated for the worker or public for this project. Likewise, chronic effects reportedly occur at doses significantly higher than that expected for the Custer National Forest weed treatment program.

There are simply too many variables (receptor sensitivity, dose received, use of personal protection, etc.) for anyone to predict with 100 percent certainty the potential health risk of herbicide use and exposure. What is known is that through a process of continual review of toxicological data on herbicides, the EPA, using very conservative assumptions, has determined a dose they believe would not result in an adverse health effect for herbicides proposed for use on this project. We know that there are studies which show that exposure to the herbicides proposed for use in high doses can cause deleterious effects. We also know that risk assessments have been completed to determine the estimated dose a worker or person of the general public might be exposed to under varying exposure scenarios. Most important, we know through a comparison of EPA established safe doses and estimated exposures that the estimated dose that people might be exposed to through use of a herbicides would be below that determined to be safe by

the EPA for a lifetime of daily exposure. Therefore, no health effects and risks to workers and the public are anticipated by the use of herbicides by the Custer National Forest.

HERBICIDE DRIFT

The air serves as a carrier of spray drift. Liquid spray droplets most prone to drift are usually 100 microns or less in diameter and most spray equipment is designed to produce 200 micron droplets. The Forest's restriction of spraying in only low wind periods reduces the chance of airborne herbicides.

Non-target plant loss from volatilization is reported to be negligible with glyphosate. Volatilization will depend on the formulation of 2, 4-D with acids and amines being less volatile than esters which vary from high to low. Any esters used on the Custer National Forest would be of low volatility. The oil soluble amines are considered to be least volatile. Dicamba may volatize from soil surfaces but further study is required to determine the extent of such losses. Picloram volatilization is not considered a problem due to the low vapor pressure of the chemical. Herbicides could be moved out of the target area while adsorbed to dust particles carried by wind. Once in the air, spray droplets are subject to photodecomposition by sunlight.

Dynamics

Spray drift is largely a function of droplet particle size, release height, and wind speed (Tesk, et. al., 1999). Other factors that control drift, to a lesser degree, include the type of spray nozzle used, the angle of the spray nozzle, and the length of the boom. The largest particles, being the heaviest, would fall to the ground sooner than smaller sizes upon exiting the sprayer. Medium size particles can be carried beyond the sprayer swath (the fan shape spray under a nozzle), but all particles would deposit within a short distance of the release point. The physics of sprayers dictates that there would always be a small percentage of spray droplets small enough to be carried in wind currents to varying distances beyond the target area. Because the small droplets are a minor proportion of the total spray volume, their significance beyond field boundary rapidly declines as they are diluted in increasing volumes of air (Felsot, 2001).

Drift characteristics differ between pesticides. With herbicides proposed in this analysis, it is not critical to coat the entire leaf since some of the product can be absorbed by the plant roots and good efficacy can be achieved by larger droplets on leaves to the target plant. Therefore, herbicide drift can be intentionally reduced by generating larger droplets without reducing efficacy.

Spray nozzle diameter, pressure, amount of water in the tank mixture, and release height of the spray are important controllable determinants of drift potential by virtue of their effect on the spectrum of droplet sizes emitted from the nozzles (Felsot, 2001; Tesk, et. al., 1999). Meteorological conditions such as wind speed and direct, air mass stability, temperature and humidity and herbicide volatility also affect drift.

Commercial drift reduction agents are available that are designed to reduce drift beyond the capabilities of the determinants previously described. These products create larger and more cohesive droplets that are less apt to break into smaller particles as they fall through the air. They reduce the percentage of smaller lighter particles that are the size most apt to drift off the treatment area.

Wind speed increases the concentration of drifting droplets leaving the treated area if the wind is adverse (blowing away from the release point in the treatment area). If the wind is favorable (blowing into the treatment area) drift can be reduced. Numerous studies have shown that over 90 percent of spray droplets land on the target area and about 10 percent or less move off-target, and that the droplets that move off-target most typically deposit within 100 feet of the target area (Felsot, 2001; Yates et al., 1978; Tesk, et. al., 1999).

Herbicide Drift from Aerial Applications

Drift deposition on surfaces measured downwind from aerial spry sites is typically less than one percent, and often less than 0.1 percent, of on site deposition (Yates et al., 1978; Tesk, et. al., 1999). Drift deposition from ground equipment can be one-tenth of that from aerial application at comparable distances from a spray site (Yates et al., 1978).

Less information is available on the concentrations of herbicides that remain airborne at greater distances from application sites. Robinson and Fox (1978) (USFS, 2005 Gallatin) measured airborne concentrations of herbicides at various distances from aerial spray plots. Under conditions designed to reduce drift, these researchers did not detect airborne levels of herbicides beyond 100 feet downwind of 500 foot wide spray plots (detection limit of 0.1 microgram – there are about 28 million micrograms in an ounce).

These researchers also measured ambient air concentrations of 2,4-D at seven stations in eastern Washington where several million acres of wheat are treated with herbicides annually. Ambient concentrations of non-volatile fractions of 2,4-D typically averaged 0.1 to 0.2 milligrams/cubic meter during periods of heavy application. Imazapic and clopyralid are also non-volatile herbicides, and long-range drift of these compounds may exhibit similar dynamics as the non-volatile fractions of 2,4-D. Therefore, the ambient concentrations of imazapic or clopyralid may be similar to the concentrations measured by Robinson and Fox (USFS, 2005 Gallatin).

Numerous investigations of factors affecting drift from aerial applications are reported in scientific literature (DiTomaso, 1999; Yates *et al.*, 1978; Robinson and Fox (1978) (USFS, 2005 Gallatin); Teske et. al., 1999; Teske et al., 2000). Three of the most comprehensive studies are discussed below.

RAHUFS Drift Estimations

The 2005 Gallatin NF Weed FEIS cites the 1992 Risk Assessment for Herbicide Use in Forest Service Regions 1, 2, 3, 4 and 10 and on Bonneville Power Administrations Sties (RAHUFS), which discusses spray drift distances downwind of an application site for aerial, back pack, and ground mechanical application equipment. The results of RAHUFS spray drift analysis indicated “low” health risk to the public from ground and aerial applied herbicides. “Low risk” was defined in the study as drift from the herbicides that presents a less than one in a million systemic, reproduction or cancer risk. Spray drift from hand application equipment was found to be negligible.

AGDRIFT / Felsot Drift Estimations

Felsot (2001) used the EPA/USDAFS AGDRIFT model to simulate herbicide sprays for several application scenarios, including a truck mounted spray boom set at two heights and a helicopter at two heights. These simulations included crosswinds blowing at ten and six mph. The model output was an estimated amount (percent of that applied) that deposited a defined distance from the edge of a spray swath. A spray deposition curve was developed to calculate a dose that a bystander could potentially receive if standing within the drift zone of an application. The whole body surface area was assumed exposed to drifting spray (highly conservative), and the bystanders were assumed to be an adult weighing 70 kilograms and a child weighing 10 kilograms. Absorption of the depositing dose was assumed to be 10 percent. Calculations were made to determine the percentage of the depositing spray that a child could be exposed to on a daily basis over 70 year life span and be within the EPA safety guidelines as defined by the reference dose (i.e., the “safe dose”). The study estimated that for aerial application, the equivalent safe deposits corresponded to distances from the edge of the spray field of 0 and about 60 feet for clopyralid, picloram, and 2, 4-D. For a ground application, the child would receive a safe dose level of 2, 4-D at 27 feet from the sprayed field edge.

Mormon Ridge Field Drift Monitoring

In this study, herbicides were aerially applied with aircraft to the Mormon Ridge winter range in 1997 and 1999. Mormon Ridge presented a difficult treatment scenario in that it is extremely steep, has rolling topography, considerable microclimate variability and aerial application occurred upslope of Mormon Creek, a bull trout –spawning stream. Mormon Creek flows along the bottom of the roughly three miles by ½ to ¾ - mile wide treatment area.

Picloram was aerial applied on Mormon Ridge in 1997. Buffer zones and water quality were monitored and continuous automated water samples collected. Analysis of the water samples (conducted by the Montana Department of Public Health and Human Services Chemistry Lab) indicated no herbicide entered the stream to a detection level of 0.1 parts per billion (USFS, SERA, 1996). The Maximum Contamination

Level as set by the EPA for drinking water is 500 parts per billion. No picloram was detected in Mormon Creek when tested at a level 5,000 times lower than the EPA Maximum Contamination Level. Drift cards were also placed along Mormon Creek to monitor drift. The cards indicated no detectable drift reached the creek.

The Mormon Ridge pilot project area was also aerial treated with picloram three growing seasons after the initial application to control invasive weeds that germinated from the soil seed bank after the herbicide decomposed. Drift cards used during this subsequent treatment did not detect picloram in the riparian aerial spray buffer.

Spray Drift Summary

Based on the above information, aerial herbicide applications would have a very short-term localized impact as a result of drift. Most of the drift would settle to within 100-200 feet of the point of release in adverse conditions. Herbicide spray drift from aerial treatments under Alternative 1 would not significantly affect the health of the general public or adversely affect water quality, provided environmental protection measures are implemented to avoid drift toward persons and sensitive resources. Aerial application should be made when there is an organized wind less than 6 mph blowing away from sensitive area. This practice combined with a buffer adjacent to sensitive areas and a drift reduction agent would likely result in no significant offsite drift. Significance in this context refers to concentrations above EPA established RfDs (see Appendix C, Protection Measures).

HUMAN HEALTH – DIRECT, INDIRECT, AND CUMULATIVE EFFECTS

HUMAN HEALTH - HERBICIDE TREATMENTS EFFECTS COMMON TO ALTERNATIVES 1 AND 3

This section addresses effects from herbicide treatments common to alternatives 1 and 3. All herbicides listed in this section pertain to Alternative 1, Proposed Action. However, only gyphosate, picloram, 2, 4-D, and dicamba pertain to Alternative 3, Current Management. Chapter 3 outlines referenced literature used to analyze potential human health risks associated with ground and aerial applications of herbicides.

Three levels of analyses were used in the above risk assessment process: 1) a review of toxicity test data (i.e., acute, chronic, and sub-chronic) for herbicides proposed for use to determine dosage that could pose a risk to human health; 2) an estimate of exposure levels to which workers (applicators) and general public may be exposed during treatment operations; and 3) comparison of dose levels to toxicological thresholds developed by EPA to determine potential health risks.

Toxicity test data on laboratory animals is available for herbicides proposed for use in this analysis. Most tests have been conducted under EPA's pesticide registration/re-registration requirements for use in the United States. The EPA uses test data to determine conditions for use of herbicides in the United States.

Label restrictions on herbicides are developed to mitigate, reduce, or eliminate potential risks to humans and the environment. Label information and requirements include: Personal Protective Equipment; User Safety; First Aid; Environmental Hazards; Directions for Use; Storage and Disposal; General Information; Mixing and Application Methods; Approved Uses; Weeds Controlled; and Application Rates. Analysis of herbicide use in this EIS assumes compliance with the product label during handling and application.

A small percentage of the population may have a hypersensitivity to the herbicides proposed for use. These people are generally aware of their sensitivities and would not be allowed to work on herbicide spray crews or in treated areas until either safe re-entry periods, or a period they feel is adequate based on their personal knowledge of their sensitivity, has passed. (Safe re-entry in areas where herbicides have been applied is when the herbicide has dried on the leaf surface).

The potential human health risks for workers and the public from herbicides would be the greatest under Alternatives 1 and 3 due to the amount of area that would be treated with herbicides. While risks to

human health are greatest under this alternative, they would still be below a level considered safe by the EPA for all herbicides proposed for use by the Custer National Forest.

Health risks to workers are greatest for ground application of herbicides. Of those areas treated by backpack, OHV, and truck mounted delivery systems, backpack applications have the greatest potential for worker exposure to herbicides. Potential for public exposure to herbicides under Alternatives 1 and 3 is low since most project areas are remote and away from population centers. Both aerial and ground applications would occur infrequently (i.e. once per year) and neither workers nor the public would receive daily exposures above the EPA reference doses, a dose considered safe by the EPA over a lifetime of daily exposure

Also, once a herbicide dries on the plant there is little risk that the chemical will transfer to people or animals who do not consume the treated vegetation. When applied to vegetation the herbicides are very dilute, below the toxicity level of the chemical.

The more time spent applying herbicides increases the risk of a spill, accident, or mishap. Risk of a herbicide spill or accident is present under Alternatives 1 and 3. In such a case workers may be directly exposed to acute concentrations of a herbicide and the general public may be secondarily exposed to a spill or release should it reach surface or groundwater. The indirect effects in the form of public exposure and disruption would be commensurate with the proximity of the spill area to the public, the amount and concentration of the herbicide, and dilution factors should the herbicide reach water. In both situations the potential effects can be mitigated through such actions as thorough washing, diluting with water, and restricting access to a spill area.

No adverse health effects are anticipated for the workers or the general public based on estimates of exposure, estimates of drift, and the protection measures that would be implemented under this alternative.

HUMAN HEALTH – NON-HERBICIDE TREATMENT EFFECTS COMMON TO ALL ALTERNATIVES

Mechanical Treatment

Potential risks to human health from mechanical weed control methods are very low and include emissions from gasoline or diesel powered equipment, burns, allergies, back injuries and skin irritation from direct contact with plants by individuals doing the work. Hypersensitive individuals may be subject to effects from gasoline engine exhaust, gasoline powered weed mowers, and vehicles used for noxious weed control and public use both in and outside the treatment areas.

Some noxious weed species can cause allergies and minor skin irritations in a few individuals. Noxious weeds, such as thistles, cause minor scrapes and irritations, and there are other more serious complications that may result from hand pulling. For example, leafy spurge contains a latex-bearing sap that irritates human skin and rarely causes blindness in humans upon contact with the eye. There have also been claims (not medically supported) that hand pulling of knapweed may result in the formation of tumors on the hands. Highly allergic individuals can have serious complications when exposed to allergens (weeds or pollen), including constriction of the airway and anaphylactic shock, the significance of which should not be underestimated since grassland workers would be working some distance from medical assistance.

Approximately 10 to 15 percent of the U.S. population suffers from allergy symptoms from noxious weed species such as knapweed. Knapweed is a common and powerful allergen that peaks in August. Allergies to weeds such as knapweed may complicate or trigger asthma.

While there is some potential for health effects associated with mechanical treatment of weeds, required personal protective equipment such as gloves, long sleeved shirts, boots and safety glasses along with personal hygiene, would prevent injuries or irritation, and therefore no significant human health effects are anticipated by mechanical removal of weeds.

Operators of machinery (such as tractor mounted mowers) could be injured by losing control of equipment on steep terrain or be coming into contact with flying debris and brush.

Smoke from burning is not expected to significantly affect human health under any alternative. Levels of suspended particulates (a suspected factor in some health problems) are expected to be well below the 150 micrograms per cubic meter (ug/m3) public welfare standard and the 260 ug/m3 public health standard published by EPA.

Workers on burn areas would be exposed to potential injury from the manual treatments they would apply and the conditions under which they would work. Workers who manually ignite burn areas would be exposed to burning materials, which could case physical injuries.

Public safety would not be affected by any method of igniting burn areas. Most burning would occur where the public either would not be present or would be highly visible to those doing the burning. Further, those on or near a burning area would be well aware of impending activities because several hours of active preparation are required before ignition begins. Although prescribed burns might “escape” control and endanger the public, safety measures normally taken to protect firefighters participating in prescribed burning would also protect the public.

To reduce the risks of burn escapes and lingering smoke, the Forest Service has special requirements for planning and implementing prescribed burns. All prescribed burn projects require a Burn Plan, which includes a burning prescription, a description and discussion of fuels, weather, and timing; how to conduct the burn; and safeguards. The safeguards section of the plan addresses all precautions needed to confine the burn to the prescribed area. In addition, the Forest Service has established qualification standards and training requirements for personnel involved in prescribed burning.

Cultural Treatment

Potential human health risks associated with cultural control methods include exposure to dust and chaff during seeding operations. Allergic reaction can result from exposure of seed and chaff when handling seeds; however, gloves, long sleeved shirts, boots, and other personal protective equipment, as needed, would prevent injuries or irritations. Therefore, no significant human health effects are anticipated by seeding.

Fertilizers are not regulated by FIFRA (Federal Insecticide, Fungicide, and Rodenticide Act). Therefore, toxicity testing and hazard identification is not as extensive as for herbicides. The primary nutrient chemicals are identified, and some constituents that have been identified as potentially hazardous by federal or state regulations are also listed. The exposure reduction practices identified in the herbicide treatment health effects analysis could also be applied to fertilizer handling and applications to reduce risk.

Biological and Grazing Treatments

Biological treatments have been employed on the Custer NF. Grazing goats and sheep is another control treatment utilized to control weeds. There are now known risks to human health resulting from the use of these biological agents or the grazing of goats and sheep.

HUMAN HEALTH - NON-HERBICIDE TREATMENT EFFECTS – ALTERNATIVE 2

Under Alternative 2, weeds would continue to spread at a rapid rate in comparison to Alternatives 1 and 3. Increase in weeds can impact individuals affected by allergies and minor skin irritations caused by certain noxious weed species. Some species of noxious weeds, such as thistle and knapweeds, cause minor scrapes and irritations.

Approximately 10 to 15 percent of the U.S. population suffers from allergy symptoms from noxious weed species such as knapweed. Knapweed pollen is a common and powerful allergen that peaks in August and produces strongly positive skin allergy tests. It is a significant allergen in causing allergic rhinitis (USFS, Lolo, 2001). Allergies to airborne seeds may complicate or trigger asthma. It may take up to two

years after getting a person's allergies under control to see a benefit in reduced asthma symptoms. Native plants also contain allergens and affect some individuals.

If noxious weeds spread unchecked, people with allergies, asthma and/or contact dermatitis would have to endure the discomfort caused by these ailments. Indirect effects on human health would increase as invasive weeds spread and affect those persons sensitive to them

There would not be any human exposure to herbicides from on NFS lands under alternative 2 and therefore human health risks are negligible.

HUMAN HEALTH - CUMULATIVE EFFECTS

Cumulative effects looks at past, present, and reasonably foreseeable activities that may have cumulative effects on human health.

Past

Past factors that may have influenced human health on the Custer National Forest include:

- Drilling, operation, and maintenance of oil and gas wells. An additional threat associated with some of these wells is the presence of hydrogen sulfide, which is a poisonous gas.
- Vehicle accidents on National Forest System Roads.
- Recreational accidents from trips and falls, horse riding, ATVs, insect stings, allergic reactions to plants and insect stings.
- Application of both pesticides and herbicides on NFS lands has likely occurred from the mid 1960's and1970s.
- The use of herbicides on private, state and other federal lands adjacent to NFS lands has probably occurred in a timeframe similar to that of the Forest Service.

There are no readily available statistics on the number of people that may have been affected as a result of the above identified past activities.

Present

Present activates on the Custer National Forest that may have an effect on human health are similar to those of the past. Additional activities include:

- The annual treatment of noxious weeds on the Custer National Forest over the last five years has ranged between 800 and 1200 net acres annually.
- Application of herbicides by adjacent federal, state, and private landowners.
- Use of biological agents i.e. flea beetles for control of leafy spurge.
- Use of mechanical methods i.e. mowing, hand and tool grubbing as a treatment tool.

Currently herbicides are be applied by private, county and federal agencies within the administrative boundaries of the Custer National Forest. In all cases applicators are required be certified for herbicide application. Herbicides are thought in all cases to be applied in accordance with EPA Label directions, including the use of prescribed personal protective equipment.

To date there are no readily available statistics of any adverse health effects being reported as a result of the use of or exposure to herbicides used for treating noxious weeds on the Custer National Forest. It is not known if application of herbicides on adjacent private or federal lands has had an additive effect on human health for people utilizing NFS lands, however, if label instruction were followed this seems unlikely.

There are no known significant health effects associated with the use of biological agents such as flea beetles, grazing of livestock or the use of mechanical methods for treating noxious weeds.

Reasonably Forseeable

Future activities will continue to include oil and gas development, recreational use, and the continued treatment of noxious weeds by, private, county, other federal agencies. In addition to these activities the following are reasonably foreseeable:

- Herbicides and biological agents are likely to be the most frequently used treatment methods in the foreseeable future under alternatives 1 and 3. Biological agents are likely to be the most frequently used treatment method under alternative 2.
- Under the proposed action, Alternative 1, various densities of infestations within approximately 15,000 gross acres would be treated over the next ten to fifteen year period under alternatives 1 and 3.
- Between 90 and 95 percent of future treatment acreage would likely be treated with ground based herbicide application and 5 to 10 percent would be aerially applied under alternative 1.
- An unknown amount of herbicide treatment would likely occur on private, state and federal lands adjacent to National Forest System lands.

Based on the results of the SERA (1999, 2003-2004) risk assessments and EPA assessments, ongoing and future activities are not expected to result in the exposure of workers or the general public to herbicide doses that exceed the reference dose (RfD). A RFD is a dose of herbicide determined to be safe by the EPA over a lifetime of daily exposure.

With respect to herbicide applications, the SERA (1999, 2003-2004) risk assessments specifically considered the effect of repeated exposure in that the chronic (long term) RfD is used as an index of acceptable exposure. The daily dose rather than the duration of exposure determines the toxicological response. Consequently, repeated exposure to levels below the toxic threshold should not be associated with cumulative effects. If EPA labels are followed the dose a worker or a person of the general public would be exposed to would be below the RfD. Exceptions to this could include acute exposure through an accidental spill or improper handling of a herbicide. Even in these situations immediate mitigation such as washing, prohibiting use or consumption of contaminated water or vegetable matter can be used to reduce or eliminate potential acute effects.

It is entirely possible past, present, and reasonable foreseeable use of herbicides may have resulted in minor impacts to human health such as rashes or other skin irritations. This may be particularly true for hyper-sensitive individuals, however, there is no cumulative evidence to suggest that the past, present, and projected use of the herbicides on the Custer National Forest, will have a cumulative significant effect on worker or public health. This assumes that EPA labels, personal protect equipment and or label requires for such things as aerial application are complied with.

It is important to note that 2, 4-D and Hexazinone offers some concern as the risk analysis shows that chronic worker exposure to ground and aerial application have hazard quotients above 1 (Table 4-6).

The risk analysis for 2, 4 D is very conservative representing a higher level of application then what the Custer NF normally uses. As discussed in the SERA (1999) risk assessment for 2, 4-D there is no evidence that overt signs of toxicity are plausible at exposures to dose levels less than 1 mg/kg/day of 2,4-D. The risk assessment modeling done for 2, 4-D used .01 mg/kg/day as the Rfd. The risk assessment notes that 2, 4-D can be applied safely if thorough and effective methods are used to protect workers and minimize exposure. The herbicide label provides direction on how to safely apply 2, 4-D and if followed exposure would be at or below the Rfd for 2, 4-D. If effective measures of hygiene are not employed, occupational exposure to 2, 4-D could result in adverse but probably not overtly toxic effects.

Hexazinone is of relatively low acute toxicity but is a severe eye irritant. Exposure to workers generally is not expected to pose undue risks, due to hexazinone's overall low acute toxicity. However, based on toxicity concerns regarding primary eye irritation, a 48-hour return entry interval is required under label. (EPA, Re-registration Decision, 9/1994).

In some accidental and extreme exposure scenarios, members of the general public may be exposed to levels of hexazinone above the RfD but still far below the levels projected for workers. While any exposure

above the RfD is considered unacceptable by definition, the exposure estimates for the general public are in a range where the occurrence and nature of potential toxic effects cannot be well characterized. For the general public, as for workers, no signs of frank systemic effects are anticipated after accidental exposure to hexazinone (EPA Re-Registration Decision, 9/1994).

EPA's regulatory conclusion is that the use of currently registered products containing hexazinone in accordance with approved labeling will not pose unreasonable risks or adverse effects to humans or the environment (EPA, 1994 RED Facts).

The additive impact of Custer National Forest use of aminopyralid relative to the effects of private application of herbicide would be very small. The sites where aminopyralid would be used will be small and non-contiguous across the Forest. Aminopyralid will typically be both broadcast and spot sprayed to direct as much of the herbicide as possible at the target weed. Aminopyralid's environmental fate and toxicological profile allow it to be used in areas where proximity of surface or ground waters constrains the use of other herbicides. Its use will replace the use of more toxic herbicides and herbicides with longer half lives (i.e. will replace 2, 4-D and/or picloram for hawkweeds, thistles, and for some areas of knapweed. Since aminopyralid is used at lower per acre rates (~ ¼ to 1/20 of the acid equivalent rate of previously established standard herbicides such as 2,4-D or picloram) and will be used on the Custer NF to replace other herbicides to a moderate degree, total doses to members of the general public from all sources of herbicides are unlikely to be higher than those estimated in the worst case scenarios described in associated risk assessments incorporated by reference in this analysis (EPA, SERA, and FS Human Health Risk Assessments).

There are no anticipated significant cumulative health effects associated with biological, grazing, mechanical, or seeding treatment of noxious weeds.

Compliance with the Forest Plan and Other Regulatory Direction

All alternatives are consistent with Environmental Protection Agency, Occupational Health and Safety Administration, State and Federal water and air quality regulations, and Forest Service regulations (FSM 2080,) regarding pesticide use and worker safety.

A biological assessment of potential effects of the preferred alternative on Threatened and Endangered (T&E) wildlife and plant species is located in the Project Record.

The purposed action is consistent with the February 3, 1999 Executive Order 13112 "to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological and human health impacts that invasive species cause."

Montana and South Dakota noxious weed laws direct County control authorities to make all reasonable efforts to develop and implement a noxious weed program. The lack of adequate weed control under Alternatives 2 and 3 would conflict with these State and County weed control plans and policies. Alternative 1 (Proposed Action) indicates that the Forest Service is committed to the management of noxious and undesirable weeds on the Custer National Forest.

Incomplete or Unavailable Information

Incomplete and unavailable information that is relevant to the toxicological tests and endpoints were considered in all EPA and Forest Service Risk Assessments (SERA, 1999-2004). Incomplete and unavailable information relating to individual herbicides is identified in each Herbicide Risk Assessment, prepared for the Forest Service under contract by SERA, Inc., BLM assessments, and in EPA Assessments. Incomplete information discussed in these assessments includes the interactions of the herbicides, associated chemicals, and other naturally-occurring and synthesized substances.

SOILS AND GROUND WATER

SOILS AND GROUND WATER - DIRECT AND INDIRECT EFFECTS

Herbicides

Herbicides used under alternatives 1 and 3 vary in their persistence in the environment and in their ability to move through the soil, and can pose an unintentional threat to groundwater quality. This analysis incorporates a hazard rating system known as Relative Aquifer Vulnerability Evaluation (RAVE) and GIS data (soil types, proximity to water, location of weeds) to determine area at risk. See the Soil and Ground Water section in Chapter 3 for a more detailed discussion on the methodology used to analyze this issue. The results from the analysis are presented below.

Table 4 - 10 shows RAVE risk classes for the entire Forest, and Table 4 - 11 proportions classes by major land unit. The RAVE map (map section), shows areas at risk for each District area of the Forest. Table 4-12 depicts areas of existing weeds (from the Custer National Forest Invasive Species Inventory) intersected with the risk areas from the RAVE model.

TABLE 4 - 10. RAVE RISK CLASSES FOR THE ENTIRE FOREST

RAVE Score Class	Acres	Percent
Low	23,824	1.9
Low to Moderate	1,222,348	95.5
High	32,819	2.6
Unacceptable	391	0.0
Total	1,279,588	

TABLE 4 - 11. RAVE RISK CLASSES BY RANGER DISTRICT

District	RAVE Score Class	Acres	Percent
Beartooth - Beartooths	Low to Moderate	502,193	95.5
Beartooth - Beartooths	High	23,449	4.5
	Total	525,642	
Beartooth - Pryors	Low	19,350	24.8
Beartooth - Pryors	Low to Moderate	58,534	75.2
	Total	77,884	
Sioux	Low	1,934	1.1
Sioux	Low to Moderate	164,174	93.4
Sioux	High	9,369	5.3
Sioux	Unacceptable	391	0.2
	Total	175,868	
Ashland	Low	2,540	0.5
Ashland	Low to Moderate	497,447	99.5
	Total	499,987	

TABLE 4 -12. % OF EXISTING WEED AREA BY RISK CLASS FOR THE FOREST

RAVE Score Class	Acres	Gross Acres of Weeds	Percent RAVE Class with Weeds
Low	23,824	24	
Low to Moderate	1,222,348	10513	92%
High	32,819	997	8%
Unacceptable	391	0	
Total	1,279,588		

Though all the factors discussed above influence rating scores, it appears that depth to groundwater and pesticide leachability account for most of the "High" ratings. No portion of the Pryor Mountains or Ashland District is rated High. All land areas of the Forest have been mapped as part of County Soil Surveys by the NRCS except for the Beartooth area. Even though the NRCS mapped all areas, mapping dates from the 1950's to the 1990's. There is a range of data and data quality that has been populated in the NASIS (National Soil Information System) database for the counties involved. For example, areas of rock outcrop can comprise significant areas of some map unit polygons. There are no data entered for these components.

The entire map unit is populated either with data from other components or is null. Also, not all map units are populated with depth to water table, so depth to groundwater may be highly variable. County soil surveys are not to be used for site specific planning because of variability in soil map unit components but can be used for broad scale applications. The data for the Beartooth area is derived from an ongoing integrated ecological unit inventory. These data are considered draft and will be updated as more work is completed. The same cautions should be considered while looking at the results for the Beartooth District. This RAVE model is designed for a programmatic planning level, and is not appropriate for on-site design. The data used in the model is accurate enough to use on a district level if mapped at that scale. This analysis provides useful "red flag" indicators for applications specialists when in areas designated "High" risk, especially when contemplating broadcast applications.

For the case using a highly-leachable herbicide, almost all of the Custer National Forest falls in the "low to moderate" risk class. Less than three percent falls in the "High" class and less than one percent in the "Unacceptable" class (Table 4 - 10). This indicates that as far as groundwater contamination is concerned, careful use of herbicides on most lands on the Forest is likely a reasonable activity. There are "hot spots" in each Ranger District where special protection measures should be considered (see RAVE map in map section). The Beartooth and Sioux Districts have the most area in this class (Table 4 - 11), primarily due to the high elevation plateaus and rocky glaciated cirque basins on the Beartooth district and because of soil textures and depth to ground water on the Sioux District associated with sedimentary plains geology.

In any of these areas, broadcast use of an alternate herbicide with a lower leachability (see Chapter 3, Table 3 -13 for herbicide leachability) should reduce risk to reasonable levels[30].

The RAVE map (see map section) shows there are some areas that should be reviewed for risks of groundwater contamination from broadcast spraying, based on the potential for contamination through existing weed infestations and potential future contamination if weeds are found in or migrate to those areas. The areas having existing weed infestations in "High" risk areas should have special protection measures designed into all current treatment plans.

Although only a small portion of weed infestations fall into the "High" risk areas (Table 4 - 12), there are some areas of specific concern. Areas having both a significant area in "High" risk and a significant area of weeds in those "High" risk areas should use herbicides that have low leaching potential or special protection measures. Areas of "Low to Moderate" risk can be evaluated at a less intense level. In terms of long term planning, areas having few weeds, but some potential for contamination should include prevention and weed surveys at a higher level than other areas to prevent the establishment of weeds into those areas. For example, the Beartooth Plateau area (see RAVE map in map section) has few weeds at

[30] High-risk areas average a score of around 70. Selecting an alternative herbicide with a low leachability gives a rating factor value of 5 rather than 20 which lowers the average score to 55, well within the "Low to Moderate" risk class (Chapter 3, Table 3 - 13).

present. However because of shallow groundwater and abundant surface water, the area is specified for special protection measures (see Appendix C) as well as increased preventative measures such as travel restrictions or washing guidelines for vehicles.

Surfactants

Based on the following studies, it appears that the ability to increase the mobility of other materials throughout the soil profile is a function of the concentration of the surfactant in the soil solution. Surfactants have been used as tools for site amelioration of soil pollution, through their ability to solubilize hydrophobic compounds.

Surfactants applied to the soil, as part of a pesticide application under alternatives 1 and 3, or in subsequent applications, would remain on the soil surface until decomposed unless driven down by water, thereby also diluting the surfactant in the soil/water system.

It appears that biodegradation of pesticides can be affected by surfactants in the soil, however this too is concentration dependent similar to desorption effects. It appears that effects to pesticide biodegradation are through preferential degradation of the surfactant rather than through a toxic action on microorganisms.

Although the potential exists for surfactants to affect the environmental fate of herbicides in soil, any potential effects would be unlikely under normal conditions because of the relatively low concentration of surfactants in the soil/water matrix (Bakke 2002). Localized effects could be seen if a spill occurred on soil, so that concentrations of surfactant approached or exceeded about 1,000 ppm.

Mechanical

Under all alternatives, mechanical weed control practices such as tilling could result in slight short-term increases in erosion. The erosion rates would quickly decline as desirable vegetation reoccupies the treated area. No impacts from mechanical treatment would occur under any alternative.

Prescribed burning of weed stands would not create the extremely high fire intensities that cause high losses of soil organic matter, the major source of nitrogen and sulphur in the soil In addition to nitrogen and sulphur, nutrients, such as calcium, potassium, and phosphorous might be lost, resulting in short-term release of nitrogen from the grunt organic matter. Soil productivity could be slightly reduced by the destruction of some soil microorganisms, but impacts would be minor and short-lived because these alternatives would not involve the intense fires that reduce microorganisms most dramatically. Short-term, slight increases in erosion could occur until vegetation reoccupies the treated area.

General Effects

Generalizing from the above discussion, it appears that under Alternatives 1 and 3 the Custer Forest has a low to moderate potential for groundwater contamination from foliar-applied herbicides. The areas of higher risk probably can be mitigated with herbicide selection to minimize that contamination potential.

A positive effect of Alternatives 1 and 3 is that weed incidence on the Forest will be reduced. The removal of exotic species is generally beneficial for the soil-part of the ecosystem and there should be beneficial effects here.

Alternative 2 will not use herbicides in areas at risk to ground water contamination so there is no associated risk. However, the weeds will continue to spread under these alternatives and this will eventually lead to a reduction in soil productivity as has been documented in the Gallatin National Forest Weed FEIS (2005), Beaverhead-Deerlodge Noxious Weed Control EIS and in the Helena National Forest Weed EIS (USFS, 2002; USFS; 2003).

CUMULATIVE EFFECTS TO SOILS AND GROUND WATER

Other foreseeable actions include treatment of weeds by other agencies or by private landowners within these areas at risk to ground water contamination. Although directions on herbicide labels prohibit applying herbicide in areas at risk to ground water contamination, people have not always followed these directions and there is always the risk of an accidental spill in an area with a high water table. However, with this analysis the areas at risk are easily discernable and herbicides that leach rapidly into the soil and aquifer will not be used in these areas. Given the protection measures there is a very low risk of ground water contamination from multiple applications of herbicides (either from multiple application within a watershed or over many years of continuous treatments).

Irreversible and Irretrievable Commitment of Resources - to Soils and Ground Water

No irreversible or irretrievable commitment of soil or ground water resources is expected to result from any of the alternatives. Protection measures are in effect to control long-term impacts from herbicide treatments: consequently, Alternatives 1 and 3 will not impact these resources. Alternative 2 will not effectively control the spread of weeds so there will be an irreversible loss of soil productivity.

Consistency with Forest Plan and other Laws, Regulations and Policies to Soils

As each alternative provides some measure of weed control, they are consistent with the Forest Plan standard, which states that management activities would be planned to sustain site productivity. They are consistent with the Soil Conservation and Domestic Allotment Act (16 USC 590), as they limit decreases in soil productivity and suppress sedimentation. These alternatives are also consistent with 43 CRF § 1901 and MCA 76-13-101 which authorize land supervisors to manage vegetation in a way that reduces soil erosion. Additionally, preventing weed propagation is consistent with related public laws outlined in Chapter 2. Alternatives 1 and 3 would be consistent with direction in the Forest Plan and other laws regarding weed control. Alternative 2 would be consistent with direction in the Forest Plan and other laws regarding weed control, but is not a very effective approach.

WATER QUALITY, FISHERIES, AND AMPHIBIANS

Impacts on aquatic organisms, including fish, amphibians, and their habitat, including Management Indicator Species and sensitive species, were analyzed by considering:

- Research results and other literature on individual herbicide characteristics and toxicities for different aquatic species;
- Studies evaluating potential for herbicide entry into surface and groundwater, via different routes (leaching, overland flow, direct application, and drift);
- Results of recent analyses conducted by other National Forests in Region 1;
- Specific protection measures comprising part of each alternative for this EIS;
- Scope of the proposed treatments;
- Treatment methods proposed within alternatives;
- Proximity of proposed treatments to water bodies supporting westslope and Yellowstone cutthroat trout and other sensitive species.

EFFECTS OF NON-HERBICIDE TREATMENTS TO ALL ALTERNATIVES

The non-herbicide treatments proposed under this alternative will have negligible effects on water resources. Mechanical treatments could result in localized soil disturbance but an increase in sediment to streams would likely be undetectable for several reasons. Disturbed areas would be minimal and localized, and would be reseeded with desirable species after treatment, reducing erosion as roots become established. Cultural treatments (seeding, transplanting, and fertilizing) would not affect fisheries or water quality. Fertilizers would be applied according to Forest Service and manufacturer guidelines.

Runoff nutrient concentrations would not be large enough to measurably enrich streams. Seeding and transplanting would involve limited soil disturbance. Release of biological control agents would have no direct effect on fisheries or surface water quality. These agents would not compete with aquatic insect species since their food base is very specific, nor would they provide more than an incidental food source for fish.

Mechanical treatments such as grazing, burning, and mowing could affect suspended sediments, total dissolved solids, or water temperature. Physical restriction on tilling (such as steep slopes) would prevent significant impacts to water quality. Tilling for weed control on a small scale with streamside buffer strips can benefit water quality. The tilling action breaks the ground surface and allows a greater infiltration rate. Infiltration rates very with soil types and slopes. But terrain restrictions and the scattered nature of weeds do not allow the widespread use of this technique. At the present time, tilling methods have not proved to be effective for the weed species found on the Custer National Forest.

Grazing with sheep or goats to control selected weeds would produce little effect on overall water quality although trampling within the stream channels could degrade water quality. Water quality indicators such as coliform numbers would increase, and in shallow streams might exceed drinking water standards. These exceedance periods, however, would extend no longer than 24 hours after livestock removal.

Burning to control weeds removes top vegetation until the next growing season or fall green up. This removal of vegetation cover would increase the potential of surface runoff and might increase suspended sediment and total dissolved solids levels in the streams until regrowth occurs. The amount of sediment reaching streams is generally proportional to the amount of bare soil in a watershed. The size of the impact from a treatment would depend on the amount of exposed soil, severity of the burn, and distance to the nearest stream.

In summary, the control of noxious weeds using methods described for this alternative would benefit both fish and amphibian habitat conditions by retaining or improving native vegetation both in riparian and upslope areas. The protection measures described above greatly reduce the likelihood that herbicide application will have any negative impacts.

WATER QUALITY, FISHERIES AND AQUATICS - EFFECTS OF HERBICIDES APPLICABLE TO ALTERNATIVES 1 AND 3

Several Forest Service environmental assessments and environmental impact statements have been conducted in recent years (Gallatin National Forest Weed FEIS (2005), Beaverhead-Deerlodge Noxious Weed Control EIS and in the Helena National Forest Weed EIS (USFS, 2002; USFS; 2003)). Individually or collectively, these analyses looked at the general effects of herbicides on the major fish, amphibians and invertebrates. None of these analyses determined that there would be significant to fisheries and other aquatic life from the proper use of these herbicides.

Herbicide Toxicity to Amphibians and Fish

Mayer and Ellersieck (1986) reviewed 4,901 acute toxicity tests of over 400 herbicides stored in the database of the US Fish and Wildlife Service, to determine if there were any statistically valid trends that could be used to compare the 66 species studied. They found there is no single species, family or class that, in all cases, is most sensitive to chemicals. They agreed with the conclusions of others, that species best represent themselves and not others, but also observed it was somewhat common that insects were more sensitive to most herbicides than crustaceans, followed by fish, then amphibians (the least sensitive class). Insects and amphibians, however, have been inconsistently studied making it hard to determine any pattern of statistical significance.

A number of herbicides proposed for use on the Custer National Forest show potential for being toxic to amphibians and fish. A general comparison of lethal toxicity levels (LC50) for salmonids and other aquatic species exposed to certain herbicides are provided in the following table. An overview of the effects of the proposed herbicides on aquatic organisms is provided in Table 4 – 13.

TABLE 4 - 13. EFFECTS OF THE PROPOSED HERBICIDES ON AQUATIC ORGANISMS[31]

Common Name	Effects to Aquatic Organisms
2,4-D	2,4-D forms range from being practically nontoxic to highly toxic to fish and aquatic invertebrates. 2,4-D amine salt forms are generally non-toxic to fish. Those compounds most toxic to fish include the 2,4-D ester formulations, N-oleyl-1,3-propylenediamine salt, and the N,N-dimethyl-oleyl-linoleylamine.
Aminopyralid	Aminopyralid is practically nontoxic to fish and aquatic invertebrate animals. It does not build up (bioaccumulate) in fish.
Chlorsulfuron	Chlorsulfuron is practically nontoxic to most fish and aquatic invertebrate animals. It does not build up (bioaccumulate) in fish.
Clopyralid	Clopyralid is of low toxicity to fish and aquatic invertebrate animals. Clopyralid does not build up (bioaccumulate) in fish tissues.
Dicamba	Dicamba is slightly toxic to fish and amphibians. It is practically non-toxic to aquatic invertebrates. Dicamba does not accumulate or build up in aquatic animals. Dicamba and its formulations have not been tested for chronic effects in aquatic animals.
Diuron	Diuron is moderately toxic to the majority of aquatic animals tested, including rainbow trout. However, it is highly toxic to cutthroat trout and scuds. Diuron is only slightly acutely toxic to fathead minnows.
Glyphosate	Glyphosate is no more than slightly toxic to fish, and practically non-toxic to aquatic invertebrate animals. It does not build up (bioaccumulate) in fish. The Accord and Rodeo formulations are practically non-toxic to freshwater fish and aquatic invertebrate animals. The Roundup formulation is moderately to slightly toxic to freshwater fish and aquatic invertebrate animals due to its pre-mixed non-aquatic surfactant. Glyphosate and its formulations have not been tested for chronic effects in aquatic animals.
Hexazinone	Hexazinone is practically nontoxic to fish, freshwater invertebrates and mollusks, and is slightly toxic to crustaceans. No toxicity studies have been reported for amphibians. No chronic studies have been reported for aquatic organisms. The liquid and solid carriers in two commercial hexazinone formulations were found to be of extremely low toxicity to fish.
Imazapic	Imazapic ranks as a “low risk” herbicide for fish, classed in the same category as 2,4-D, glyphosate, clopyralid, dicamba, and metsulfuron methyl. Neither published literature nor the U.S. EPA files include data regarding the toxicity of imazapic to amphibian species. Aquatic organisms appear to be relatively insensitive to imazapic exposure, relative to both direct toxicity and reproductive effects.
Imazapyr	Imazapyr and its formulations are low in toxicity to invertebrates and practically non-toxic to fish. Imazapyr is not expected to accumulate or build up in aquatic animals. Imazapyr and its formulations have not been tested for chronic effects in aquatic animals.
Methsulfuron methyl	Metsulfuron methyl is practically nontoxic to fish and aquatic invertebrates. Metsulfuron methyl does not build up (bioaccumulate) in fish.
Picloram	Picloram is moderately to slightly toxic to freshwater fish, and slightly toxic to aquatic invertebrate animals; it does not build up in fish. The formulated product is generally less toxic than picloram. Picloram and its formulations have not been tested for chronic effects in aquatic animals.
Sulfometuron methyl	Sulfometuron methyl is slightly toxic to fish and aquatic invertebrates. The potential for sulfometuron methyl to build up in fish tissues (bioaccumulate) is low.
Triclopyr	Triclopyr is low in toxicity to fish. The ester form of triclopyr, found in Garlon 4, is more toxic, but under normal conditions, it rapidly breaks down in water to a less toxic form. Triclopyr does not accumulate in fish. Triclopyr is slightly toxic to practically non-toxic to invertebrates. Triclopyr and its formulations have not been tested for chronic effects in aquatic animals.

[31] http://www.fs.fed.us/foresthealth/pesticide/index.shtml and EPA 9/30/2003.

Below is a summary of risk characterization to aquatic species for each herbicide from human health and ecological risk assessment documents prepared for the Forest Service (USFS, SERA 199-2004). These summaries relate the expected direct effects of exposure and ingestion. They do not address the indirect effects of habitat alteration.

2, 4-D

Under any foreseeable set of conditions (during Forest Service use), no impact is anticipated in any aquatic species from the general use of 2, 4-D in a watershed.

Aminopyralid

Aminopyralid has been shown to be practically non-toxic to fish and aquatic invertebrates. Aminopyralid is slightly toxic to eastern oyster, algae and aquatic vascular plants. Aminopyralid is not expected to bioaccumulate in fish tissue.

There are no acute or chronic risks to non-target endangered or non-endangered fish, birds, wild mammals, terrestrial and aquatic invertebrates, algae or aquatic plants.

Clopyralid

The risk characterization for aquatic animals is limited by the relatively few animal and plant species on which data are available compared to the large number of species that could potentially be exposed. This limitation and consequent uncertainty is common to most if not all ecological risk assessments.

The risk assessment for aquatic organisms is relatively simple and unambiguous. Clopyralid appears to have a very low potential to cause any adverse effects in any aquatic species.

Chlorsulfuron

The risk characterization for aquatic animals is relatively simple and unambiguous. Chlorsulfuron appears to have a very low potential to cause any adverse effects in aquatic animals. All of the hazard quotients for aquatic animals are extremely low, ranging from 8^{-10} (longer term exposures in tolerant invertebrates) to 0.001 (acute exposures to sensitive aquatic invertebrates). At the maximum application rate of 0.25 lbs/acre, the risk characterization is unchanged: the highest hazard quotient 0.001 would be increased to 0.005, below the level of concern by a factor of 200.

Dicamba

The risk characterization for aquatic animals is extremely limited by the available toxicity data. For the characterization of risk, NOEC values are not used directly and risks are characterized 50 using LC values. Another very substantial limitation in the risk characterization is that no information is available on the chronic toxicity of dicamba to aquatic animals and the available acute toxicity data do not permit reasonable estimates of toxicity values for chronic toxicity. Within these very serious limitations, there is little basis for asserting that adverse effects in aquatic animals are plausible. This conclusion is consistent with a recent assessment by the U.S. EPA on the impact of dicamba on Pacific anadromous salmonids.

Diuron

Diuron is moderately toxic to the majority of aquatic animals tested, including rainbow trout, bluegill sunfish, water flea, striped mullet, sheepshead minnow, Eastern oyster, and brown shrimp. However, it is highly toxic to cutthroat trout and scuds. Diuron is only slightly acutely toxic to fathead minnows. In chronic studies, diuron reduced the number of surviving fathead minnows, the growth and survival of sheepshead minnows, and the growth and reproduction of mysid shrimp.

Acute risk quotients for freshwater fish and invertebrates are relatively low ranging from 0.03 to 2.6; however, limited incident data suggest that diuron may pose an acute risk to fish. Chronic risk quotients for freshwater fish range from 0.3 to 9. Acute and chronic risk quotients for estuarine and marine fish and

invertebrates are low, with the highest risk quotient of 1.3 for chronic risk to marine invertebrates, based on the 12 lb. application rate to rights-of-way.

The protection measures required for labeling under the 2003 EPA re-registration decision serves to decrease risk to non-target species.

Glyphosate

The primary hazards to fish appear to be from acute exposures to the more toxic formulations. At the typical application rate of 2 lbs a.e./acre, the hazard quotients for the more toxic formulations at the upper ranges of plausible exposure indicate that the LC50 values for these species will be not reached or exceeded under worst-case conditions. At an application rate of 7 lbs a.e./acre, the acute exposures are estimated to slightly exceed the LC50 value for typical species and exceed the LC50 value for sensitive species by a factor of about 2. In these worst-case scenarios, the exposure estimates are based on a severe rainfall (about 7 inches over a 24 hour period) in an area where runoff is favored – a slope toward a stream immediately adjacent to the application site. This is a standard worst-case scenario used in Forest Service risk assessments to guide the Forest Service in the use of herbicides. This risk characterization strongly suggests that the use of the more toxic formulations near surface water is not prudent.

The use of less toxic formulations results in acute hazard quotients that do not approach a level of concern for any species. Nonetheless, the hazard quotient of 0.08 for sensitive species at an application rate of 2 lbs/acre is based on an LC50 value rather than a NOEC. Thus, the use of glyphosate near bodies of water where sensitive species of fish may be found (i.e., salmonids) should be conducted with substantial care to avoid contamination of surface water. Concern for potential effects on salmonids is augmented by the potential effects of low concentrations of glyphosate on algal populations.

The likelihood of direct acute toxic effects on aquatic invertebrates or longer term direct effects on any fish species seems extremely remote based on central estimates of the hazard quotient and unlikely base on upper ranges of the hazard quotient. The hazard quotient of 0.044 for longer term effects of the more toxic formulations on sensitive fish is based on an estimated NOEC and thus is not, in itself, of substantial concern.

Hexazinone

The toxicity of hexazinone to aquatic species is well-characterized. Comparable studies on aquatic algae and aquatic animals clearly indicate that most algal species are much more sensitive to hexazinone, compared with fish and aquatic invertebrates. By analogy to the toxicity of hexazinone to terrestrial plants, it seems likely that aquatic macrophytes also may be very sensitive to the toxic effects of hexazinone. Other than lethality, the most common effect noted on aquatic animals is growth inhibition, which is also the most sensitive effect in experimental mammals. Only one study regarding amphibians was located, and it suggests that amphibians are less sensitive than fish or aquatic invertebrates to hexazinone.

Imazapic

Adverse effects in aquatic animals do not appear to be likely. The weight of evidence suggests that no adverse effects in fish or aquatic invertebrates are plausible using typical or worst-case exposure assumptions at the typical application rate of 0.1 lb/acre or the maximum application rate of 0.1875 lb/acre. As in any ecological risk assessment, this risk characterization must be qualified. Imazapic has been tested in only a limited number of species and under conditions that may not well-represent populations of free-ranging nontarget animals. Notwithstanding this limitation, the available data are sufficient to assert that no adverse effects on animals are anticipated based on the information that is available.

Imazapyr

Adverse effects in aquatic animals do not appear to be likely. The weight of evidence suggests that no adverse effects in fish or aquatic invertebrates are plausible using typical or worst-case exposure assumptions at the typical application rate of 0.45 lb/acre or the maximum application rate of 1.25 lb/acre. As in any ecological risk assessment, the risk characterization must be qualified. Imazapyr has been

tested in only a limited number of species and under conditions that may not well-represent populations of free-ranging non-target organisms. Notwithstanding this limitation, the available data are sufficient to assert that no adverse effects on animals are anticipated based on the information that is available.

Metsulfuron Methyl

The risk characterization for aquatic animals is relatively simple and unambiguous. Metsulfuron methyl appears to have a very low potential to cause any adverse effects in aquatic animals. All of the hazard quotients for aquatic animals are extremely low, with a range in fish from 3^{-10} (acute exposures in tolerant fish) to 3^{-5} (longer-term exposures to sensitive fish). It should be noted that confidence in this risk characterization is reduced by the lack of chronic toxicity studies in potentially tolerant fish – i.e., bluegill sunfish trout. At the maximum application rate of 0.15 lbs/acre, all of the hazard quotients would be increased by a factor of about 5. However, this difference has no impact on the risk characterization for fish. Hazard quotients in aquatic invertebrates range from 7^{-10} (acute exposure in Daphnia) to 7^{-7} (acute exposure in Daphnia). Thus, there is no basis for asserting that adverse effects on aquatic animals are likely.

Picloram

There is substantial variability in the toxicity of picloram to aquatic species. While this variability adds uncertainty to the dose-response assessment, it has no substantial impact on the risk characterization. None of the hazard indices for fish, aquatic invertebrates, or aquatic plants reach a level of concern. The risk characterization for both terrestrial and aquatic species is limited by the relatively few animal and plant species on which data are available compared to the large number of species that could potentially be exposed. This limitation and consequent uncertainty is common to most if not all ecological risk assessments.

Sulfometuron Methyl

Sulfometuron methyl appears to have a very low potential to cause any adverse effects in aquatic animals. All of the hazard quotients for aquatic animals are extremely low, with a range of 2^{-9} (lower range for acute exposures in tolerant aquatic invertebrates) to 0.004 (longerterm exposures to amphibians). It should be noted that confidence in this risk characterization is reduced by the lack of chronic toxicity studies in potentially tolerant fish and potentially sensitive aquatic invertebrates and lack of data in amphibians (data only available in a single species). Even with these uncertainties, there is no basis for asserting that adverse effects on aquatic animals are likely.

Triclopyr

Both triclopyr and the insecticide chlorpyrifos produce the metabolite 3, 5, 6-trichloro-2-pyridinol (TCP). TCP is similar in toxicity to triclopyr and less toxic than chlorpyrifos. The risk characterization for TCP is considered quantitatively only for fish because toxicity data are available only for fish. At the typical application rate of 1 lb a.e./acre, the worst case hazard quotients are below the level of concern. That the maximum application rate of 10 lbs a.e./acre, the hazard quotients would be a factor of 10 higher and the hazard quotient for longer term exposure would be substantial (hazard quotient = 9). Thus, if triclopyr is applied at higher rates of exposure in areas where surface water contamination is plausible, site-specific modeling and/or environmental monitoring would be useful to ensure and verify that concentrations TCP do reach harmful concentrations. Concentrations of TCP in surface water after the application of triclopyr at 1 lb a.e./acre and chlorpyrifos at 1 lb a.e./acre are well below a level of concern. Thus, the concern for TCP residues in surface water appears to be associated with high application rates of triclopyr rather than applications of triclopyr and chlorpyrifos in the same area.

Surfactants

Effects on aquatic organisms are driven by the same dose-response principles as any other group of organisms (i.e., dosage thresholds can be determined for various effects). There are interspecies differences, as well as differences within species depending upon age; however the results of studies on the same surfactants are consistent with each other. It does appear that in general, the surfactants used in forestry can affect aquatic organisms at lower doses than for terrestrial organisms (Bakke 2002).

Surfactants are proposed for use with the same protection measures as picloram (see Appendix C). Only those labeled for use in and around water would be used within 50 feet of water, or the edge of subirrigated land, whichever distance is greater, or on high run-off areas. Some surfactants are labeled for use in and around water including: Activate Plus ®, LI-700 ®, Preference ®, R-11 ®, Widespread® and X-77®.

WATER QUALITY, FISHERIES, AND AMPHIBIANS - DIRECT AND INDIRECT EFFECTS - ALTERNATIVE 1 (PROPOSED ACTION)

General Effects – Herbicide Application

Potential effects to aquatic organisms from noxious weed management are largely associated with herbicide application on and around streams, lakes or wetlands. Contamination can occur through direct herbicide contact with surface water from either inadvertent application or accidental spill. It may also occur indirectly when herbicides are routed through ditch and irrigation channel networks, routed from adjacent slopes through overland flow, or through contaminated groundwater inflow from herbicides previously leached through soils. Each route of entry results in varied magnitude and duration of contamination.

Aerial spraying near aquatic zones has the most potential to expose aquatic organisms to contaminants, either through direct application or drift. The high potential is due to the inability to target only exact weed locations or completely control drift, both of which can result in unnecessary or inaccurate application of herbicides.

Ground-based application of herbicides may also enter streams directly or through drift. However, the risk of contamination from ground-based equipment is lower because the application is localized and more controlled. Applicators are able to immediately recognize problems and adjust application techniques.

Indirect routing of herbicides to surface waters through overland flow processes is a consideration for some herbicides. Risks vary with the persistence of active ingredients, soil and vegetation characteristics and condition, and the intensity and timing of precipitation events following herbicide application. Overland flow occurs infrequently on most well vegetated forests and rangelands because soil infiltration capacity is generally greater than precipitation. Compacted soil with sparse vegetation typically results in increased potential for surface runoff. The likelihood that an isolated, intense storm would occur right after herbicide application and center itself on a treated area is very low. However, as a risk reduction measure, review of weather forecasts prior to herbicide application is a required protection measure. Using weather forecasts to guide applications should reduce the probability that overland flow would route herbicides to adjacent waterbodies. Based on results from Watson, Rice and Monnig (1989), photo-decay of picloram ranged from 22 to 44 percent within seven days.

Leaching through the soil profile is also a routing mechanism, but generally poses the least risk to aquatic environments. While there are exceptions, most herbicides disappear quickly from both the ground surface and soil. Reduced potential for leaching is largely facilitated by plant uptake of the herbicide, natural decomposition and volatilization of active ingredients, and/or adsorption of the herbicide by soil particles. Most groundwater contamination by herbicides results from point sources such as spills and leaks at storage and handling facilities, improperly discarded containers, or rinsing equipment at inappropriate locations. Point sources are generally discrete, identifiable locations that discharge relatively high local concentrations of herbicides. Such problems can be avoided through proper handling of herbicide containers and application equipment.

Impacts of weed infestations on amphibians have not been adequately evaluated. Maxell (2000) indicated, however, that non-native aquatic and terrestrial weeds can form dense stands that may exclude native amphibians, thus reducing available habitat. Weed management with chemical herbicides have the potential to impact amphibian communities. Many amphibians have vascularization in the epidermis of the skin, which allows easy absorption of toxicants (Maxell 2000). Effects of chemical contamination range from direct mortality to sublethal effects, such as reductions in disease resistance, changes in growth, decreased reproductive ability and morphological abnormalities (Cooke 1981; Hall and Henry 1992; Boyer and Grue 1995; Carey and Bryant 1995).

Specific Effects – Herbicide Application

Of the herbicides proposed for use on the Custer National Forest, picloram has the greatest potential to impact aquatic fauna. It persists longer than other herbicides, is slightly to moderately toxic to aquatic organisms, and is currently being used to control weeds on the Forest. Results from the risk analysis described in Chapter 3 are listed in Table 4 - 14. These results are based on herbicide application over the course of one field season. The results assume that the accumulation of persistent herbicides over time will not occur to a significant degree because 1) picloram has a half life of 90 days, and 2) repeat aerial application over consecutive years is highly unlikely.

TABLE 4 - 14 – SURFACE WATER RISK ANALYSIS (Beartooth District – Picloram Analysis)

Watershed		Weed Polygon Areas		Herbicide (pounds of picloram)		Streamflow		Maximum Allowable Annual Treatment	
6th HUC Number	Acres	Actual infested noxious weed acres	Proposed aerial treatment areas	Applied to land surface at 0.25lb/ac[32]	Routed to surface waters at 0.015 routing coefficient[33]	Estimated low flow (Q95) (cfs)	Estimated concentration of picloram in receiving waters (ppm)[34]	Total acres - all treatment types	Percent of aerial polygon[35]
100700050110	42055	0	0	0.0	0.0	9.0	0.000	243	N/A
100700050120	18344	0	0	0.0	0.0	4.3	0.000	116	N/A
100700050130	14482	39	0	9.8	0.1	3.5	0.031	94	N/A
100700050140*	114666	84	0	20.9	0.3	22.0	0.011	594	N/A
100700050150	43337	4	0	1.0	0.0	9.2	0.001	249	N/A
100700050160#	31710	10	516	47.7	0.7	7.0	**0.076**	189	37
100700050170*#	215911	206	5442	527.6	7.9	38.8	**0.151**	1046	19
100700050210	35382	3	0	0.8	0.0	7.7	0.001	208	N/A
100700050220*	72361	11	0	2.9	0.0	14.6	0.002	394	N/A
100700050230*#	92378	11	0	2.9	0.0	4.6	0.007	125	N/A
100700050240#	25909	4	0	1.0	0.0	5.8	0.002	157	N/A
100700050310#	11770	35	852	83.3	1.2	2.9	**0.321**	78	9
100700050320*#	23295	41	2701	246.6	3.7	42.5	0.065	1146	42
100700050330#	12177	3	23	2.8	0.0	3.0	0.010	80	100
100700050340	16840	0	0	0.0	0.0	4.0	0.000	107	N/A
100700050410	30501	0	0	0.0	0.0	6.8	0.000	182	N/A
100700050420*	60280	5	0	1.3	0.0	12.4	0.001	335	N/A
100700050430#	17932	3	0	0.8	0.0	4.2	0.002	113	N/A
100700050440#	22469	10	0	2.5	0.0	5.1	0.006	139	N/A
100700060101	39469	0	0	0.0	0.0	8.5	0.000	229	N/A
100700060104	22390	0	0	0.0	0.0	5.1	0.000	138	N/A
100700060105	27497	0	0	0.0	0.0	6.2	0.000	166	N/A
100700060107	24177	0	0	0.0	0.0	5.5	0.000	148	N/A
100700060511	24881	13	0	3.3	0.0	5.6	0.007	152	N/A
100700060601#	39543	0	0	0.0	0.0	8.5	0.000	230	N/A
100700060606*#	37019	3	0	0.8	0.0	8.0	0.001	217	N/A
100700060607#	16700	3	0	0.7	0.0	3.9	0.002	106	N/A
100700060608#	28441	0	0	0.0	0.0	6.3	0.000	171	N/A
100700060901#	32086	7	0	1.6	0.0	7.1	0.003	191	N/A
100700060902	24206	1	0	0.2	0.0	5.5	0.000	148	N/A
100700060903*	82414	68	0	34.0	0.5	16.4	0.023	443	N/A
100700060904	21136	0	0	0.1	0.0	4.9	0.000	131	N/A
100700060905*	43703	58	0	28.9	0.4	9.3	0.035	251	N/A
100700061001#	30089	4	0	1.0	0.0	6.7	0.002	180	N/A
100700061002#	21694	0	0	0.0	0.0	5.0	0.000	134	N/A
100700061005	32363	51	54	17.4	0.3	7.1	0.027	192	100
100800100501	13739	38	0	9.5	0.1	3.3	0.032	89	N/A
100800100502*#	35357	40	0	10.0	0.2	7.7	0.014	208	N/A

32 100% of infested acres and 35% of aerial acres treated. 0.25 lb/ac rate used assuming typical mix with 2,4-D for effective aerial treatment of similar area weeds by local Stillwater and Carbon County aerial application rates.

33 Assumes 50 percent of the treatment acres are runoff dominant with a routing coefficient of 0.02, and 50 percent are infiltration dominant with a coefficient of 0.01.

34 Compare values to the 0.075 ppm threshold. Values listed in **bold** exceed this threshold and indicate where surface water risk should be reassessed during aerial contract preparation. The threshold value was derived by taking 1/20 of the 96 hour LC-50 for cutthroat trout (1/20th of 1.5 ppm).

35 Assumes no ground-based treatment occurs during the same year.

Watershed		Weed Polygon Areas		Herbicide (pounds of picloram)		Streamflow		Maximum Allowable Annual Treatment	
6th HUC Number	Acres	Actual infested noxious weed acres	Proposed aerial treatment areas	Applied to land surface at 0.25lb/ac[32]	Routed to surface waters at 0.015 routing coefficient[33]	Estimated low flow (Q95) (cfs)	Estimated concentration of picloram in receiving waters (ppm)[34]	Total acres - all treatment types	Percent of aerial polygon[35]
100800100503#	15650	0	0	0.1	0.0	3.7	0.000	100	N/A
100800100504#	20370	0	0	0.0	0.0	4.7	0.000	127	N/A
100800100801#	22737	0	0	0.0	0.0	5.2	0.000	140	N/A
100800140401#	31025	48	0	12.0	0.2	6.9	0.019	185	N/A
100800140402*#	68121	50	0	12.5	0.2	13.8	0.010	373	N/A
100800140403#	90333	50	0	12.5	0.2	17.8	0.008	480	N/A
100800140404#	129195	50	0	12.6	0.2	24.5	0.006	661	N/A
100800140405#	22125	0	0	0.0	0.0	5.1	0.000	137	N/A
100800140502#	37344	0	0	0.0	0.0	8.1	0.000	218	N/A

*All values in these watersheds are corrected to account for cumulative influence of contributing watersheds upstream.

These watersheds have significant acreage below the Forest boundary. The degree of noxious weed infestation and the amount of herbicide applied on private land is unknown, and therefore not accounted for in the values listed.

These results suggest that ground based application of picloram at 0.25 lb/acre is not likely to exceed safe concentrations in any of the watersheds evaluated. This is mainly due to the low level of weed infested acres within these watersheds, but also due to the relatively high estimated Q95 flow.

These results also suggest that half (those reflected with bold type in the above table) of the six watersheds with proposed aerial application (Beartooth District Stillwater and Dry Creek areas) will likely exceed safe concentrations under the assumption that 35% of the aerial mapped polygon is treated (see Map Section - Beartooth District Alternative One). Aerial applications in these areas under the assessment assumptions would need to limit the treatment acres with picloram as shown in the above table, or use herbicides approved for use near surface water.

However, during contract preparation for aerial application, surface water quality risk with more site-specific information will be re-assessed (see Protection measures, Appendix C). Once the exact treatment areas are delineated in preparation for the contract, treatment acres can be determined for 6th hydrologic unit code (HUC) watersheds potentially affected by aerial application. These delineated areas can be incorporated into the risk assessment to estimate probable herbicide concentrations and allowable treatment acres. If concentrations exceed the recommended safe threshold, treatment acres would need to be reduced to the allowable amount.

Risks to water quality and aquatic biota still exist through accidental drift, accidental spill or misuse of herbicides. Additionally, although the Ashland and Sioux Districts were not incorporated in the risk assessment above, risks still exist to isolated springs and perennial stream segments. Protection measures were developed to address all of these risks. These measures are identified as Protection measures in Appendix C.

By adhering to all label instructions and protection measures (Appendix C), herbicide concentrations in streams are expected to remain at safe levels and therefore negative impacts to sensitive or Management Indicator Species should not occur. This conclusion assumes that project implementation and protection measures described in the EIS are adhered to.

WATER QUALITY, FISHERIES, AND AMPHIBIANS - DIRECT AND INDIRECT EFFECTS - ALTERNATIVE 2 (NO HERBICIDE)

Effects of the herbicide application under this alternative are non-existent since treatments would be entirely bio-control, cultural, or mechanical. However, if these other treatments are less effective, other indirect effects associated with reduced vegetative cover, and increased surface runoff and sedimentation, may be higher than under Alternative 1.

Other indirect effects can result from alterations in the composition of vegetative ground cover through proliferation or reduction of noxious weeds. On sloped terrain, the possibility of surface runoff and sediment introduction into streams and other waterbodies increases as weeds replace bunchgrasses and other vegetation. If sediment introduction is excessive, fish habitat and amphibian habitat could be negatively affected (Platts, 1991; Maxell, 2000). Instream cover for fish might also change, based on alterations in riparian vegetation along stream margins. Additional effects to fish could include short-term changes in food supply, should aquatic invertebrates be susceptible to low concentrations of herbicides.

WATER QUALITY, FISHERIES, AND AMPHIBIANS - DIRECT AND INDIRECT EFFECTS - ALTERNATIVE 3 (NO CHANGE FROM CURRENT MANAGEMENT)

Since this alternative does not provide for aerial treatments, significantly less herbicide would be applied across the landscape on the Beartooth District as compared to Alternative 1. Therefore, the risks to water quality and fish from herbicides are reduced from those described for Alternative 1. Application methods under this alternative rely solely on biological and mechanical means. Mechanical treatment has minimal effects in relation to the entire Custer National Forest.

WATER QUALITY, FISHERIES, AND AMPHIBIANS - CUMULATIVE EFFECTS

Activities considered in the cumulative effects analysis include those directly modifying fish and amphibian habitat as well as those indirectly modifying sediment delivery and routing, and modifying hydrologic regimes. These activities include past road construction and stabilization, vegetation management, grazing, recreation, trail maintenance, and past wildfires (Table 4 - 15).

TABLE 4 - 15. COMMON ACTIVITIES AND ASSOCIATED LEVELS OF IMPACTS

Activity	Typical Habitat Alteration or Impact on Aquatic Species	Current Degree of Impact
Livestock grazing	Bank alteration, stream channel over-widening, sediment introduction	Low to high
Timber harvesting	Sediment introduction, reduction of woody debris recruitment potential, modified water temperature regimes	Low to high
Road building	Sediment introduction, migration barriers	Moderate to high
Recreation (non-fishing)	Sediment introduction, habitat modification	Low
Recreational fishing	Hooking and handling mortality; harvest	Low to moderate
Water withdrawal	Reduction of instream flows	Low to high
Dams	Altered water temperatures, fish migration barriers, altered sediment transportation, altered aquatic communities, altered flow regimes	Low to high
Lake fish stocking	Competition/hybridization between introduced species and native species	Moderate to high
Noxious weed management	Chemical poisoning of aquatic organisms	Low

Herbicide application will also occur within some watersheds by county weed control districts and private landowners. The Forest Service projects are directly regulated by the protection measures in this EIS. Although the Forest Service has no direct jurisdiction over weed control methods by counties or private landowners, their herbicide applications are regulated by EPA label requirements. Assuming county and private landowner herbicide applications follow these requirements, measurable direct/indirect effects on water quality and fisheries are not likely. The exception would be in the unlikely event that herbicide applications by all entities coincided in time, space and type of herbicide applied. This is especially true in watersheds where the risk analysis indicates thresholds values are close to being exceeded.

As proposed, Alternatives 1 and 3 are not expected to cumulatively interact with past, current, and reasonably foreseeable actions to negatively impact sensitive amphibian populations. Alternatives 1 and 3 are also not expected to have negative cumulative impacts on sensitive fish populations. Alternative 2 will maintain existing cumulative effects to amphibians and sensitive fish populations.

BIOLOGICAL EVALUATION DETERMINATION

Fish and Amphibian Species

Risk of impacting sensitive fish and aquatic life stages of amphibians is directly related to possible herbicide contamination of streams and lakes, and the necessity for water quality conditions to allow individuals throughout all life stages of development and maturation to remain healthy. Risk is indirectly related to effects on aquatic insects, used for food, and riparian and upslope vegetation, necessary to maintain many physical elements of desired habitat characteristics.

Effects to fish and sensitive amphibians from mechanical removal of weeds are considered discountable due to minimal ground disturbance and the limited extent it will occur. Biological control of weeds may have slight beneficial effects. There are no negative impacts associated with biological control.

Susceptibilities to chemical weed treatment are not well defined for amphibian species, as with other aquatic organisms. Their life histories involve both aquatic and terrestrial life stages, making them susceptible to toxicants in both environments. Many amphibians have vascularization in the epidermis of the skin, with little keratinization, simplifying uptake of many toxicants.

Effects on terrestrial life stages of amphibians must be viewed somewhat differently. It is likely that adult or subadult amphibians within riparian zones will come into direct contact with herbicides during or after application. Chemical contamination was reviewed in Cook (1981) and others, (as reported in Maxell 2000). Effects, (although not necessarily from the specific chemicals proposed for use in this document) ranged from mortality to reduced disease resistance, reproductive ability, and morphological abnormalities (Maxell 2000). While amphibians' vulnerability to chemicals is well documented, there is no data that allows us to effectively define what effects might occur from incidental contact with the herbicides proposed for use in this EIS. Many assume that criteria for mammals, birds, and fish will incorporate the protection needed for amphibians (Maxell 2000). For this analysis, it is assumed some risk to individuals may be present but impacts are not predictable.

Within the proposed action alternative, direct contact with herbicides by amphibians will be largely incidental. The broader more continuous coverage of aerial application will not occur in riparian zones, where sensitive amphibians are likely to be found in large numbers. Ground application consists largely of spot application, reducing risk of exposure for high numbers of individuals. Amphibian species can occur in extremely high densities around water bodies, shortly after they metamorphose from tadpoles into young adults. This situation can pose a risk to relatively large number of individuals during ground application in the riparian zones. The occurrence of high concentrations of amphibians will likely be observed during required inspections immediately adjacent to water bodies, prior to ground application. In these cases treatment will be postponed (within the area occupied) until the individuals have adequately dispersed, or weeds can be hand pulled or treated by wick application. Therefore, the proposed action, with these protection measures, is expected to pose little risk to amphibian populations and their habitat.

Based on short exposure times and likely concentration levels that are well below those shown to cause adverse effects to aquatic organisms, it is concluded that risk for adverse effects to sensitive fish and amphibian species in surface waters is low enough to be considered discountable.

Further, many of the cold-water fisheries on the Custer National Forest are located within the Absaroka-Beartooth Wilderness. Therefore, it is expected that the degree of impact on fishes and amphibians in this area would be minimal and would vary little among alternatives. The proposed action, with the protection measures, is expected to pose little risk to fish and amphibian populations and their habitat outside of the Absaroka-Beartooth Wilderness as well. This action may impact individuals, based on the slight risk of a spill, but will not impact populations of sensitive fish and amphibian species on Custer National Forest lands (Table 4 - 16).

TABLE 4 - 16. BIOLOGICAL EVALUATION FOR SENSITIVE AQUATIC SPECIES

Species	Determination	Comments
Northern Red Belly Dace	MIIH	Based on the slight risk of a spill.
Sturgeon Chub	MIIH	Based on the slight risk of a spill.
Yellowstone Cutthroat	MIIH	Based on the slight risk of a spill.
Great Plains Toad	MIIH	Based on the slight risk of a spill.
Northern leopard frog	MIIH	Based on the slight risk of a spill.
Plains Spadefoot	MIIH	Based on the slight risk of a spill.
Western toad	MIIH	Based on the slight risk of a spill.

MIIH – May Impact Individuals, but will not lead toward listing or loss of viability to the species.

Monitoring Requirements

Monitoring for aerial application will consist of detection cards as described in Appendices C and N.

A field inspector will be present during all aerial application to monitor drift using Spray detection cards placed in buffer areas along any stream or lake comprising a sport fishery, or waters important for Threatened, Endangered or Sensitive (TES) aquatic species. Cards will be placed prior to herbicide application and will be sufficient in number and distribution to adequately determine when drift of herbicide into the buffer area exceeds acceptable levels.

Consistency with Forest Plan and other Laws, Regulations and Policies to Water Quality, Fisheries, and Amphibians

All alternatives would meet all water quality standards and maintain beneficial uses of surface water and groundwater resources, assuming implementation of protection measures occurs as necessary. Alternatives 1 and 3 would be consistent with direction in the Forest Plan and other laws regarding weed control. Alternative 2 would be consistent with direction in the Forest Plan and other laws regarding weed control, but is not a very effective approach and could allow for increased spread of aquatic weeds.

SENSITIVE PLANT SPECIES

Each alternative was evaluated based on the following criteria: how vulnerable to weed invasion are known populations and their habitat, how will known sites be treated; effectiveness of treatment to stop or reduce the spread of weeds known populations and their habitat; and will the treatment have a detrimental impact on the sensitive plants.

SENSITIVE PLANTS - EFFECTS OF NON-HERBICIDE TREATMENTS TO ALL ALTERNATIVES

Forest Service policies and protection measures (see Appendix C) give sensitive plant species special attention. Mechanical treatments will avoid or protect known sensitive plant populations and therefore there is very low risk of impacting viability of known populations.

Mechanical and burning control measures could potentially impact unidentified sensitive plant populations. Tilling weeds could impact sensitive plant populations by direct mortality of plants or temporary setback of plant health. Some plant propagules (growing parts) may be retained after tilling and allow some plants to grow back. Burning for weed control could impact some species, especially if fire intensity and severity is extreme enough to kill root crowns, effectively killing the plants. However, many species evolved with fire and can survive, especially if the population occurs in a habitat that is in good to excellent condition and burns are of moderate to low severity/intensity.

When in suitable habitat of listed Sensitive Plants, a survey would precede mechanical treatments that could impact sensitive plant population viability. Populations discovered during these surveys will be avoided or protected in accordance with applicable Forest Service policy (FSM 2670).

SENSITIVE PLANTS - DIRECT AND INDIRECT EFFECTS - ALTERNATIVE 1

There is little to no vulnerability to weed invasion in the known or potential sites for Barratt's willow (alpine conditions), Musk-root (very rocky), Dakota buckwheat (very shallow soils), and Shoshonea (very shallow, rocky, and exposed soils). There is no threat to Barratt's willow from herbicide treatment in adjacent areas since adjacent areas are generally alpine or subalpine conditions where weeds typically cannot get a foothold. However, there could be a threat from adjacent area herbicide use on Musk root, Dakota buckwheat, Shoshonea, and the remainder of the sensitive plant species. However, with the following protection measures outlined in Appendix C, the risk that herbicides will be accidentally sprayed on sensitive plants is very low:

Based on these features of the proposed action and protection measures outlined in Appendix C, a biological evaluation has been conducted for these sensitive plant species (Table 4 – 17). Analysis presented within this EA serves as documentation of the biological evaluation.

Over time new sensitive plant sites will be discovered and new plants will be added to the sensitive plant list while some may be dropped. Under this alternative, adaptive management allows for treating areas to prevent weed spread into new sensitive plant sites.

SENSITIVE PLANTS - DIRECT AND INDIRECT EFFECTS - ALTERNATIVE 2 (NO HERBICIDES)

There is little to no vulnerability to weed invasion in the known or potential sites for Barratt's willow (alpine conditions), Musk-root (very rocky), Dakota buckwheat (very shallow soils), and Shoshonea (very shallow, rocky, and exposed soils). The remainder of the sensitive plant species is vulnerable to weed invasion.

With this alternative the known sensitive plant sites cannot be effectively protected from invasive plants with only manual or biological treatments. Not all of the invasive plants infestations, near known sensitive plant populations, can be effectively pulled (i.e., weeds that are rhizomatous such as with Canada thistle and yellow toadflax or populations that are too large for effective treatment) and only some of the weed species currently have effective biocontrol agents. On these sites the invasive plants will continue to spread without the integration of herbicide use

Due to limited funding, hand grubbing can only be implemented on a limited number of acres. Also, grubbing plants that spread via roots requires excavating the soil, which is detrimental to the sensitive plant. Sites where weeds spread is by roots will not be manually treated and weed spread cannot be controlled or contained by hand pulling.

Only Barratt's willow, Musk-root, Dakota buckwheat, and Shoshonea will be protected due to little or no vulnerability from invasion and no effect from herbicides since they are not proposed for use under this alternative.

For the remainder of the sensitive plant species, this alternative will offer very little protection to the known sensitive plant sites and their habitat from invasion from exotic plants. Activities (and lack of herbicide integration) under this alternative will cause a greater loss in these remaining sensitive plant populations and "Will impact individuals or habitat with a consequence that the action may contribute to a trend towards federal listing or cause a loss of viability to the population or species". It is important to note that although the use of herbicides, under Alternatives 1 and 3, may kill some individual plants, there would be a far greater loss of species diversity which would result from further uncontrolled weed infestations.

Over time new sensitive plant sites will be discovered and new plants will be added to the sensitive plant list while some may be dropped. Under this alternative, adaptive management is not considered and does not allow for treating areas to prevent weed spread into new sensitive plant sites:

SENSITIVE PLANTS - DIRECT AND INDIRECT EFFECTS - ALTERNATIVE 3 (NO CHANGE FROM CURRENT MANAGEMENT)

The risk with this alternative is that herbicides will accidentally be sprayed on sensitive plants. However, the risk is very low with most species due to proximately to current infestations and associated herbicide treatment. Currently, only Beartooth Goldenweed is in close proximity to known weed infestations and has potential for some drift from current spot herbicide treatment.

Over time new sensitive plant sites will be discovered and new plants will be added to the sensitive plant list while some may be dropped. Under this alternative, adaptive management is not considered and does not allow for treating areas to prevent weed spread into new sensitive plant sites as well as in the AB Wilderness Area.

SENSITIVE PLANTS - CUMULATIVE EFFECTS

The spatial boundary for this analysis is limited to the Custer National Forest and some of the adjacent lands (private and federal). The boundary follows topographic features (such as streams, and ridges), and roads (see the map in project file, rare plants section). These features are physical barriers that allow for more effective weed control.

The temporal boundary includes all known sensitive plant locations that have been identified within the last 10 ten years and all reasonably foreseeable activities that may impact these locations over the next five years.

The following activities are within the spatial and temporal boundaries, and are included in the cumulative effects analysis: weed control effort on land adjacent to the Custer National Forest; and other activities on the Custer National Forest that contribute to the spread of weeds near sensitive plant locations (such as timber harvest, prescribed and natural fires, recreation sites, and grazing).

First, if adjacent landowners do not control their weeds there is a risk that the weeds will spread to the National Forest and impact sensitive plants. Since Alternative 1 is more efficient in controlling the spread of invasive plants, this alternative would be able to respond to this type of situation with a more effective weed control program. Alternatives 2 and 3 would not be able to stop the spread invasive plants, because the tools are less effective (biological control agents are only effective on a few plants and pulling rhizomatous plants is detrimental to sensitive plants) or the location was not included in the 1987 environmental analysis so would not be treated (i.e., the No Action Alternative 3). If the weeds are being controlled on adjacent lands there is slight risk that the herbicides will impact the sensitive plants on the Custer National Forest. Most of the rare plants are more than 50 feet from the boundary and the herbicide is not likely to move this distance (either by drifting or by leaching) at concentrations that are lethal to the sensitive plants. However, there is one species with a known location near National Forest / non-Forest boundaries.

Second, other activities such as timber harvest, prescribed fires, recreation sites, and grazing may impact the spread of invasive plants and inadvertently impact sensitive plants. Prior to implementing all activities a sensitive plant survey and a weed risk assessment would be completed. The activities would be modified to mitigate the impact to the sensitive plants or the risk of spreading weeds. Also, the Best Management Practices for Noxious Weeds (FS Manual 2080) lists activities that will be incorporated into the management of these activities to help prevent the spread of weeds. Alternative 1 is most efficient in controlling the spread of invasive plants. Alternative 2 would not be able to stop the spread of invasive plants, because the tools are less effective (biological control agents are only effective on a few plants and pulling rhizomatous plants is detrimental to sensitive plants). Alternative 3 would be less effective than Alternative 1 since sensitive plant locations and some protection measures, along with allowances for use of other herbicides were not included in the 1987 environmental analyses.

BIOLOGICAL EVALUATION DETERMINATIONS

Table 4 - 17 provides the determination of effects to sensitive plant species listed for the Custer National Forest that may occur in the analysis area.

TABLE 4 - 17. EFFECTS DETERMINATIONS TO SENSITIVE PLANT SPECIES

Species	1 Proposed Action	2 No Herb.	3 No Action	Statement of Rationale
Adoxa moschatellina Musk-root	MIIH[36]	NI[37]	MIIH	Alternatives 1 and 3: No vulnerability to invasion and low probability of impacting population viability from herbicide with protection measures. Alternative 2: No vulnerability to invasion or herbicide.
Asclepias ovalifolia Ovalleaf milkweed	MIIH	WIFV[38]	MIIH	Alternatives 1 and 3: Low probability of impacting population viability from herbicide with protection measures. Alternative 2: High vulnerability to invasion and impacting a trend toward listing.
Astragalus barrii Barr's milkvetch	MIIH	WIFV	MIIH	Alternatives 1 and 3: Low probability of impacting population viability from herbicide with protection measures. Alternative 2: High vulnerability to invasion and impacting a trend toward listing.
Carex gravida var. gravida	MIIH	WIFV	MIIH	Alternatives 1 and 3: Low probability of impacting population

[36] MIIH = May impact individuals or habitat but will not likely contribute to a trend towards listing or loss of viability to the population or species
[37] NI – No impact
[38] WIFV = Will impact individuals or habitat with a consequence that the action may contribute to a trend towards federal listing or cause a loss of viability to the population or species

Species	1 Proposed Action	2 No Herb.	3 No Action	Statement of Rationale
Pregnant sedge				viability from herbicide with protection measures. Alternative 2: High vulnerability to invasion and impacting a trend toward listing.
Cypridium calceolus var. parviflorum Small Yellow lady's-slipper	MIIH	WIFV	MIIH	Alternatives 1 and 3: Low probability of impacting population viability from herbicide with protection measures. Alternative 2: High vulnerability to invasion and impacting a trend toward listing.
Epipactis gigantea Giant Helleborine	MIIH	WIFV	MIIH	Alternatives 1 and 3: Low probability of impacting population viability from herbicide with protection measures. Alternative 2: High vulnerability to invasion and impacting a trend toward listing.
Eriogonum visherii Dakota buckwheat	MIIH	NI	MIIH	Alternatives 1 and 3: No vulnerability to invasion and low probability of impacting population viability from herbicide with protection measures. Alternative 2: No vulnerability to invasion or herbicide.
Gentiana affinis Prairie gentian	MIIH	WIFV	MIIH	Alternatives 1 and 3: Low probability of impacting population viability from herbicide with protection measures. Alternative 2: High vulnerability to invasion and impacting a trend toward listing.
Gentianopsis simplex Hiker's Gentian	MIIH	WIFV	MIIH	Alternatives 1 and 3: Low probability of impacting population viability from herbicide with protection measures. Alternative 2: High vulnerability to invasion and impacting a trend toward listing.
Haplopappus subsquarrosus var. subsquarrosus	MIIH	WIFV	MIIH	Alternatives 1 and 3: Low probability of impacting population viability from herbicide with protection measures. Alternative 2: High vulnerability to invasion and impacting a trend toward listing.
Juncus hallii Hall's Rush	MIIH	WIFV	MIIH	Alternatives 1 and 3: Low probability of impacting population viability from herbicide with protection measures. Alternative 2: High vulnerability to invasion and impacting a trend toward listing.
Primula incana Mealy Primrose	MIIH	WIFV	MIIH	Alternatives 1 and 3: Low probability of impacting population viability from herbicide with protection measures. Alternative 2: High vulnerability to invasion and impacting a trend toward listing.
Mertensia ciliata Mountain bluebells	MIIH	WIFV	MIIH	Alternatives 1 and 3: Low probability of impacting population viability from herbicide with protection measures. Alternative 2: High vulnerability to invasion and impacting a trend toward listing.
Ranunculus jovis Jove's Buttercup	MIIH	WIFV	MIIH	Alternatives 1 and 3: Low probability of impacting population viability from herbicide with protection measures. Alternative 2: High vulnerability to invasion and impacting a trend toward listing.
Salix barrattiana Barratt's willow	NI	NI	NI	Alternatives 1 and 3: No vulnerability to invasion and no probability of impacts from herbicide. Alternative 2: No vulnerability to invasion or herbicide.
Shoshonea pulvinata Shoshonea	MIIH	NI	MIIH	Alternatives 1 and 3: No vulnerability to invasion and low probability of impacting population viability from herbicide with protection measures. Alternative 2: No to low vulnerability to invasion or herbicide.

Effects to Custer National Forest "watch" species, *Lomatium nuttallii*, follow: Alternatives 1 and 3: Low probability of impacting population viability from herbicide with protection measures. Alternative 2: High vulnerability to invasion and impacting population trends.

Irreversible and Irretrievable Commitment of Resources to Vegetation

Implementation of Alternatives 1 or 3 with appropriate protection measures and site rehabilitation would result in no irreversible or irretrievable loss of native plant communities. Currently, native plant communities are more at risk from invasion and displacement by invasive weed populations. Implementing Alternatives 2 or 3 could result in irretrievable impacts to native plant communities on some areas if noxious weeds spread from untreated areas and dominate large areas that cannot be treated under existing policies, locations (i.e. the AB Wilderness Area) and methods of weed control. With Alternatives 2 or 3 weeds would continue to proliferate and control measures would not be sufficient to prevent continued expansion of weeds and associated losses in native plant communities.

Consistency with Forest Plan and other Laws, Regulations and Policies to Vegetation

Alternatives 1 and 3 would be consistent with direction in the Forest Plan and other laws regarding weed control. Alternative 2 would be consistent with direction in the Forest Plan and other laws regarding weed control, but is not a very effective approach.

WILDLIFE

WILDLIFE - DIRECT AND INDIRECT EFFECTS

Visitors to the Custer National Forest enjoy large and diverse wildlife populations. Dense infestations of noxious weeds have major impacts on ecological conditions that support the existence of wildlife. Noxious weeds reduce wildlife forage, alter thermal and escape cover, change water flow and availability to wildlife, and may reduce territorial space necessary for wildlife survival.

Areas dominated by leafy spurge receive three times less use by deer and four times less use by bison compared with similar uninfested areas. On native bunchgrass sites in Montana, dense spotted knapweed populations reduce available winter forage for elk by 50 to 90 percent. Elk use increased almost four times after dense spotted knapweed infestations were controlled on these sites. On wetlands, invasions of purple loosestrife and saltcedar degrade habitat for furbearing animals and waterfowl. In the intermountain west, medusahead and cheatgrass invasions have increased the frequency of fires and reduced native shrub communities important for wildlife winter habitat (Sheley, et. al., 2005).

There is a concern that weed treatments may impact wildlife by herbicide toxicity, by habitat modification, and by displacement during treatment. For analysis purpose the wildlife species will be divided into three groups for each alternative: Threatened and Endangered Species; Sensitive Species; and Management Indicator Species/Key Species. Protection measures by alternative are found in Appendix C.

WILDLIFE - EFFECTS OF HERBICIDES APPLICABLE TO ALTERNATIVES 1 AND 3

Several Forest Service environmental assessments and environmental impact statements have been conducted in recent years (USFS Pacific Northwest Region, 2005, USFS Gallatin Weed FEIS, 2005, USFS Beaverhead-Deerlodge, 2002, and USFS Helena, 2003). Individually or collectively, these analyses looked at the general effects of the herbicides (Appendix G) on the major groups of wildlife species. None of these analyses determined that there would be significant effects to wildlife from the proper use of these herbicides, including protection measures outlined in Appendix C.

Herbicide Toxicity to Terrestrial Mammals and Birds

Exposure of terrestrial animals to herbicides may result from several actions including direct spray application, ingestion of plants or other items that have been sprayed, grooming, and indirect contact with vegetation that has been sprayed or inhalation of spray. Wildlife may become in contact with contaminated vegetation, or ingest contaminated vegetation or prey.

Pesticides have been identified as a major cause of mortality for numerous species. Organophosphorus and carbamate insecticides are currently the chemicals most commonly associated with mass mortality of wildlife, especially migratory birds (Vyas, 1999). The herbicides proposed for use on the Custer National Forest (Appendix G) are made up of different chemical compounds (phenosyaliphatic acids, triazoles, bensoics, and phosphonomethyl).

The effects of many herbicides on mammalian and avian wildlife have not been studied in detail, although most herbicides have been tested on laboratory animals (especially rats, mice, rabbits, and dogs). Findings are then extrapolated to wildlife (USFS - SERA, 1995-2004), which means that conclusions regarding the effects of these chemicals on wildlife are somewhat uncertain. However, risk levels for herbicide use are calculated in a very conservative manner and worst-case exposure scenarios have been studied for most herbicides.

Lethal Dose 50 (LD50) values are used as a measure of toxicity and are defined as the quantity of chemical per unit body weight that would cause lethal effects in 50 percent of a study population with a single dose. Reported LD50 values for herbicides were sometimes highly variable (Table 4-19), reflecting differences among studies such as use of different species or exposure techniques, varying sample sizes, etc. Despite this variability in LD50's, data is sufficient to determine that the herbicides proposed for use under the Proposed Action are generally of low toxicity to mammalian and avian wildlife (Table 4-19).

Exposure to extremely high levels of most herbicides through direct ingestion or spraying during laboratory studies often lead to death or a variety of sub-lethal toxic effects including damage/irritation to the nervous system, kidneys, eyes, skin; inhibition of reproduction; and other problems. However, the doses required to produce such effects were much higher than those wildlife would encounter from application of herbicides in the field even under worst-case scenarios.

In addition to the active ingredients in chemicals used for weed control, commercial herbicide formulations contain various inert ingredients. These ingredients have been placed in four categories by the Environmental Protection Agency according to their toxicity (Moore, 1987). The categories are: 1) inerts of toxicological concern; 2) potentially toxic inerts/high priority for testing; 3) inerts of unknown toxicity; and 4) inerts of minimal concern. The majority of inerts are currently in category 3, indicating that there is a large degree of uncertainty regarding the effects of inert ingredients. Also largely unknown are the possible synerginistic effects of various inert ingredients and pesticides.

The long-term fate of herbicides in the environment is also a concern. Bioaccumulation is the process by which chemicals enter the food chain from the environment, whereas bio-magnification is the increase in concentration of these chemicals from one link in the food chain to the next. Small concentrations of chemicals, from combined effects of these processes, can lead to toxic effects especially for organisms high in the food chain. However, for bio-magnification to occur, the chemical must be long-lived, mobile, and fat-soluble. If a chemical is not long-lived, it will break down before entering the food chain. If it is not mobile, such as when it is bonded to soil, it is unlikely that it could be taken up by an organism. If it is water-soluble rather than fat-soluble, it will be excreted by the organism. The herbicides proposed for use in this project appear to be rapidly excreted (Tatum, 2004, Miller et. al., 2004, USFS, SERA 1995 – 2004) and do not accumulate in tissues. Because of this, these herbicides present a low risk for bio-magnification. Tables 4 – 18 and 4 – 19 outline herbicide toxicity to mammals and birds.

TABLE 4 – 18. ECOTOXICOLOGICAL CATEGORIES

Toxicity Category	Mammalian (Acute Oral)* mg/kg	Avian (Acute Oral)* mg/kg	Avian (Dietary)- ppm	Aquatic Organisms‡ ppm
very highly toxic	<10	<10	<50	<0.1
highly toxic	10-50	10-50	50-500	0.1-1
moderately toxic	51-500	51-500	501-1000	>1-10
slightly toxic	501-2000	501-2000	1000-5000	>10-100
practically non-toxic	>2000	>2000	>5000	>100

*Reflects dose given to test animals and is based on body weight of the test animal.
-Concentration in the diet. Unrelated to body weight of the test animal. Measure of environmental exposure.
‡Concentration in water. Unrelated to body weight of test animal. Measure of environmental exposure.

TABLE 4 - 19. MAMMALIAN TOXICITY OF HERBICIDES[39]

Chemical name (common brand names)	Mammalian toxicity (LD50 in mg/kg body weight)	Avian Toxicity (LD50 in mg/kg body weight)	Risk Assessment
2,4-D (amine form) (Hi-Dep, Weedar 64, Weed RHAP A-4D, Weed RHAP A)	[1]moderate (639 >5,000) [2]low /moderate (100-1800)	[1]low/moderate (472->2,000) [2]low/moderate (300-5,000)	Good data for mammals and birds; birds somewhat less sensitive than mammals; exposure not expected to cause observable adverse signs of toxicity but may lead to eye or skin irritation; exposure at higher than expected levels also affects kidneys, nervous system, and thyroid and may lead to vomiting, diarrhea, and muscle twitches.
Aminopyralid[40]	very slightly toxic	Low/moderate	There are no acute or chronic risks to non-target endangered

[39] Unless otherwise posted, data are from *Human Health and Ecological Risk Assessments* (ERA), Syracuse Environmental Research Associates, Inc. (http://www.fs.fed.us/foresthealth/pesticide/risk.htm)
[40] EPA 2005

Chemical name (common brand names)	Mammalian toxicity (LD50 in mg/kg body weight)	Avian Toxicity (LD50 in mg/kg body weight)	Risk Assessment
(Milestone)	(>5000)	(>2250 - >5556)	or non-endangered birds, wild mammals, and terrestrial invertebrates.
Chlorsulfuron (Telar)	[1]nearly nontoxic (<5,000) [3]very slightly toxic (5,545)	[1]nearly nontoxic (<5,000) [3]very slightly toxic (>5,000)	Most data are from experimental mammals, there is some uncertainty about extrapolating conclusions to wildlife; potential for adverse effects to mammals and birds appears to be remote.
Clopyralid (Stinger, Reclaim, Transline)	[1]low (none given) [2]low (>3,000-5,000)	[1]low (none given) [2]low (1,465)	Well studied in experimental mammals but not birds or other wildlife; potential for adverse effects to mammals and birds appears to be remote, given available data.
Dicamba (Banvel, Banex, Trooper)	[1]slightly toxic (566-3,000) [2]low (600->3,000)	[1]nearly nontoxic (673-2,000) [2]low (none given)	Most data are from experimental mammals, there is some uncertainty about extrapolating conclusions to wildlife; toxic effects unlikely for application rates at or above those normally used.
Diuron[41]	Low (2,900)	Practically nontoxic (9000)	The highest calculated avian acute risk quotient based on a single application of diuron at 12 lbs a.i./A to rights-of-way. The acute levels of concern are exceeded for birds feeding on short grass, tall grass and broadleaf plants and insects. However, levels of concern are not exceeded if risk quotients are calculated using mean estimated exposure concentrations based on mean residues from Hoerger and Kenega 1972 as modified by Fletcher et al. 1994. Chronic avian toxicity data is not currently available for diuron. The acute and chronic levels of concern for mammals is only exceeded for 15 gram mammals feeding on short grass following a 12 lb a.i./A application of diuron to rights-of-way. Diuron is practically non-toxic to honeybees and risk to non-target insects is expected to be minimal.
Glyphosate (Roundup, Rodeo, Accord)	[1]nearly nontoxic (none given) [2]low (1,500->5,000)	[1]nearly nontoxic (3,850) [2]low (1,500->5,000)	Good data on mammalian and avian wildlife; toxic effects very unlikely even at highest allowable application rates.
Hexazinone (Velpar, Velpar ULW, Velpar L, Pronone 10G)	[1]nearly nontoxic (none given) [2]low (none given)	[1]nearly nontoxic (3,850) [2]low (2,258)	Most data are from experimental mammals, there is some uncertainty about extrapolating conclusions to wildlife; available data indicate it is unlikely to cause adverse effects to terrestrial species; ingestion of crystals by birds immediately after application may cause reproductive effects or overt signs of toxicity.
Imazapic	[2]low (none given)	[2]low (none given)	Most data are from experimental mammals, there is some uncertainty about extrapolating conclusions to wildlife; larger mammals affected more than smaller, however adverse effects to mammals or birds are unlikely under typical or worst-case cases of exposure.
Imazapyr (Arsenal, Chopper, Contain)	[1]nearly nontoxic (4,800-5,000) [2]low (none given)	[1]nearly nontoxic (<2,150) [2]low (none given)	Most data are from experimental animals, there is some uncertainty about extrapolating conclusions to wildlife; little data on toxic levels; sufficient data are available to conclude that adverse effects to terrestrial species are unlikely under typical or worst-case cases of exposure.
Metsulfuron methyl (Escort, Ally)	[1]nearly nontoxic (none given) [2]low (>2,000)	[1]nearly nontoxic (<2,150) [2]low (>2,000)	Most data are from experimental mammals, there is some uncertainty about extrapolating conclusions to wildlife; sufficient data are available to conclude that adverse effects to terrestrial species are unlikely under typical or worst-case cases of exposure; may cause weight loss at sub-lethal doses.
Picloram (Tordon, Grazon, Access, Pathway)	[1]low (<950-8,200) [2]low (3,000-5,000)	[1]nearly nontoxic (<2,000) [2]low (>2,000)	Most data are from experimental mammals, there is some uncertainty about extrapolating conclusions to wildlife; adverse effects to mammals or birds are unlikely under typical or worst-case cases of exposure.

[41] EPA, 9/30/2003, p. 71

Chemical name (common brand names)	Mammalian toxicity (LD50 in mg/kg body weight)	Avian Toxicity (LD50 in mg/kg body weight)	Risk Assessment
Sulfometuron methyl (Oust)	[1]low (<5,000 *ppm*) [2]low (none given)	[1]low (<5,620 *ppm*) [2]low (none given)	Very limited data on birds; observable effects to most mammals & birds not expected; possible reproductive effects to some species although evidence is not conclusive.
Triclopyr (Garlon, Grazon)	[1]slightly toxic (310-713) [2]low (none given)	[1]very low (1,698) [2]low (none given)	Good data for birds and mammals; application rates at or above those normally used not expected to affect terrestrial animals.

Below is a summary of risk characterization to terrestrial species for each herbicide from human health and ecological risk assessment documents prepared for the Forest Service (SERA 1999-2004) and EPA. These summaries relate the expected direct effects of exposure and ingestion. They do not address the indirect effects of habitat alteration.

2, 4-D

Except for accidental exposure scenarios, there is relatively little indication that 2,4-D applications are likely to cause any adverse effects in terrestrial animals. For small mammals, a reasonable verbal interpretation of the direct spray scenarios is that signs of frank toxicity are unlikely but subclinical effects could result in some species. The direct spray scenario for the bee is less ambiguous: some populations of bees subject to a direct spray could evidence substantial mortality. An major consideration in all of the direct spray scenarios involves interception of the 2,4-D by vegetation. This would tend to reduce the level of exposure but the magnitude of the reduction would depend on the proportion of the 2,4-D that is intercepted prior to contacting the animal. While this cannot be well quantified in general, it may account for the failure of some field studies to note toxicity in bees after the application of 2,4-D.

Neither of the drinking water scenarios led to hazard quotients that reach a level of concern. For the longer-term drinking water scenario, the anticipated exposures are far below a level of concern. As in the characterization of risk for potential human health effects, both the acute and longer term exposures of a small mammal to vegetation contaminated with 2,4-D are of some concern. Nonetheless, given the conservative nature of the exposure assumptions as well as the marginal nature of the hazard quotients - i.e., 0.5 to 2 - it seems reasonable to assert that, at least in some and perhaps most instances, actual exposures would be below and sometimes far below a level of concern. Nonetheless, if contaminated vegetation is the sole diet of the animal, some subclinical toxic effects could occur. No frank signs of toxicity, however, are likely.

A very conservative multi-route exposure scenario supports a concern for potential although perhaps isolated effects on terrestrial vertebrates. The dose-response assessment on which this hazard characterization is based is most clearly relevant to mammalian species. However, because the dose-response assessment encompasses more sensitive species - i.e., larger mammals - and the exposure assessment is based on a smaller mammal, the assessment is inherently conservative.

Although the data on avian species are not as extensive as those for mammals, acute toxicity studies in birds suggest that avian species are somewhat less sensitive than mammals. In addition, the available studies on the effects of 2, 4-D on avian eggs suggest that no effects would be anticipated from a direct spray of avian eggs at application rates of up to 10 lb/acre, a rate that is far in excess of those anticipated by the Forest Service.

Aminopyralid

Aminopyralid has been shown to be practically non-toxic to birds, honeybees, and earthworms. There are no acute or chronic risks to non-target endangered or non-endangered birds, wild mammals, and terrestrial invertebrates.

Clopyralid

No adverse effects are anticipated in terrestrial or aquatic animals from the use of clopyralid in Forest Service programs at the typical application rate of 0.35 lb a.e./acre. The same qualitative assessment holds for the maximum application rate of 0.5 lb a.e./acre except for the large bird feeding exclusively on contaminated vegetation over a 90 day period. Other more plausible scenarios – i.e., the longer term consumption of vegetation contaminated by drift or the longer term consumption of contaminated water or fish – yield hazard quotients that are in the range of 0.00005 to 0.02, far below a level of concern.

The risk characterization for both terrestrial and aquatic animals is limited by the relatively few animal and plant species on which data are available compared to the large number of species that could potentially be exposed. This limitation and consequent uncertainty is common to most if not all ecological risk assessments.

Chlorsulfuron

Just as there is little reason to doubt that adverse effects on some plant species are plausible, there is no clear basis for suggesting that effects on terrestrial or aquatic animals are likely or would be substantial. Adverse effects in mammals, birds, terrestrial insects, and microorganisms are not likely using typical or worst-case exposure assumptions at the typical application rate of 0.056 lb a.e./acre or the maximum application rate of 0.25 lb a.e./acre. One study has suggested that latent/sublethal chlorsulfuron toxicity to one plant species could result in adverse reproductive effects in one species of beetle that consumes the leaves of the affected plant. This appears to be a highly specific plant-insect interaction and this effect has not been noted in subsequent studies by the same group of investigators using other plant-insect pairs. As with the human health risk assessment, this characterization of risk must be qualified. Chlorsulfuron has been tested in only a limited number of species and under conditions that may not well-represent populations of free-ranging nontarget species. Notwithstanding this limitation, the available data are sufficient to assert that no adverse effects are anticipated in terrestrial animals.

Dicamba

For terrestrial vertebrates, some acute exposure scenarios but no chronic exposure scenarios exceed the level of concern but only at the highest application rate. At the typical application rate of 0.3 lb/acre, no adverse effects on mammals or birds are plausible for either acute or chronic exposures. At the highest application rate of 2 lb/acre, adverse reproductive effects are plausible in acute exposure scenarios involving mammals and birds consuming contaminated vegetation or contaminated insects. In chronic exposure scenarios at an application rate 2 lb/acre, the hazard quotients associated with the consumption of contaminated vegetation are below the level of concern by factors of 5 to over 16,000. There is little basis for asserting that adverse effects would be expected in terrestrial insects or soil microorganisms. The very limited data in insects suggest that no lethal effects are likely in a direct spray. There are no data on sublethal effects in insects. At the highest application rate, transient effects might be seen in some populations of soil microorganisms.

Diuron

Diuron is slightly toxic to bobwhite quail and practically nontoxic to mallard duck on an acute oral basis. It is practically nontoxic to bobwhite quail and slightly toxic to mallard duck on a subacute dietary basis. Diuron is relative nontoxic to both honey bees and laboratory rats (acute basis). In a 2-generation rat reproduction study, diuron caused pup body weight loss. Avian reproduction information is not available.

In general, most acute risk quotients for terrestrial wildlife were below the most conservative EPA level of concern. However, direct spray of the pollinating insect resulted in elevated risk quotients at both the typical and maximum application rates. In addition, at the maximum application rate, risk was also predicted for the pollinating insect from indirect contact with foliage impacted by direct spray. These are highly conservative scenarios assuming that the insect absorbs 100% of the herbicide after application with no herbicide degradation or limitations to uptake by the insect. Therefore, these scenarios may overestimate risk to the insect.

Risk quotients for acute ingestion scenarios were below the most conservative level of concern when herbicide is applied at the typical application rate, but above the level of concern in all cases at the maximum application rate. Risk quotients for chronic ingestion scenarios were above the associated level of concern of 1.0 for three receptors (the small and large mammalian herbivores and the large mammalian carnivore) when herbicide is applied at the typical application rate. At the maximum application rate, elevated risk quotients were predicted for all evaluated scenarios. This evaluation indicates that direct spray impacts may pose a risk to insects, birds, and mammals, primarily when the maximum application rate is used.

EPA's ecological risk assessment shows minimal exceedance of the levels of concern for acute risk to birds. Chronic risk to birds could not be calculated due to a lack of chronic avian toxicity data; these data are required.

Chronic RQs for very small mammals (15 grams) range from 0.1 to 9.2; all other mammalian RQs are below levels of concern.

The protection measures required for labeling under the 2003 EPA re-registration decision serves to decrease risk to non-target species.

The EPA developed a Endangered Species Protection Program to identify pesticides whose use may cause adverse impacts on endangered and threatened species, and to implement protection measures that address these impacts. EPA did not require specific label language at the 2003 re-registration time relative to threatened and endangered species. The general risk mitigation required through the 2003 EPA re-registration decision will serve to protect listed species of potential concern until such time as the EPA refines its risk assessment for birds, mammals, aquatic species and plants from the uses of diuron.

Glyphosate

The current risk assessment for glyphosate generally supports the conclusions reached by U.S. EPA: Based on the current data, it has been determined that effects to birds, mammals, fish and invertebrates are minimal. At the typical application rate of 2 lbs a.e./acre, none of the hazard quotients for acute or chronic scenarios reach a level of concern even at the upper ranges of exposure for terrestrial organisms. For the application rate of 7 lbs a.e./acre, central estimates of the hazard quotients somewhat exceed the level of concern for the direct spray of a honey bee. That the upper range of the hazard quotients, the level of concern is exceeded modestly in acute scenarios for a large mammal consuming contaminated vegetation and a small bird consuming insects. In the chronic exposure scenarios, the hazard quotient for a large bird consuming contaminated vegetation on site exceeds the level of concern by a factor of about 3. As with all longer term exposure scenarios involving the consumption of contaminated vegetation, the plausibility of this exposure scenario is limited because damage to the treated vegetation – i.e., vegetation directly sprayed at the highest application rate – would reduce and perhaps eliminate the possibility of any animal actually consuming this vegetation over a prolonged period.

Hexazinone

Effects on terrestrial species is based primarily on the available data on experimental mammals. Although the limited data available on the toxicity of hexazinone to wildlife species and the observations from the available field studies do not suggest a cause for substantial concern, field studies are not usually designed to detect effects on nontarget species.

As summarized in the human health risk assessment, hexazinone has a low order of acute toxicity to mammals. As noted in the hazard identification for ecological effects there is relatively little information regarding the toxicity of hexazinone to other terrestrial animals. The information on birds suggests that the acute and subchronic lethal potency of hexazinone to birds and mammals is similar.

For nontarget terrestrial species, the approach will be similar to that taken in the human health risk assessment, except that uncertainty factors will not be used because data are available on nontarget species.

Imazapic

Adverse effects in terrestrial animals do not appear to be likely. The weight of evidence suggests that no adverse effects in mammals, birds, fish, and terrestrial or aquatic invertebrates are plausible using typical or worst-case exposure assumptions at the typical application rate of 0.1 lb/acre or the maximum application rate of 0.1875 lb/acre. As in any ecological risk assessment, this risk characterization must be qualified. Imazapic has been tested in only a limited number of species and under conditions that may not well-represent populations of free-ranging nontarget animals. Notwithstanding this limitation, the available data are sufficient to assert that no adverse effects on animals are anticipated based on the information that is available.

Imazapyr

Adverse effects in terrestrial animals do not appear to be likely. The weight of evidence suggests that no adverse effects in mammals, birds, fish, and terrestrial or aquatic invertebrates are plausible using typical or worst-case exposure assumptions at the typical application rate of 0.45 lb/acre or the maximum application rate of 1.25 lb/acre. As in any ecological risk assessment, the risk characterization must be qualified. Imazapyr has been tested in only a limited number of species and under conditions that may not well-represent populations of free-ranging non-target organisms. Notwithstanding this limitation, the available data are sufficient to assert that no adverse effects on animals are anticipated based on the information that is available.

Metsulfuron Methyl

Just as there is little reason to doubt that adverse effects on some plant species are plausible, there is no clear basis for suggesting that effects on terrestrial or aquatic animals are likely or would be substantial. Adverse effects in mammals, birds, terrestrial insects, and microorganisms are not likely using typical or worst-case exposure assumptions at the typical application rate of 0.03 lb a.e./acre or the maximum application rate of 0.15 lb a.e./acre. This characterization of risk, however, must be qualified. Metsulfuron methyl has been tested in only a limited number of species and under conditions that may not well-represent populations of free-ranging nontarget species. Notwithstanding this limitation, the available data are sufficient to assert that no adverse effects are anticipated in terrestrial animals.

Picloram

The potential for adverse effects on other terrestrial nontarget animal species appears to be remote. The weight of evidence suggests that no adverse effects in terrestrial animals are plausible using typical or even very conservative worst case exposure assumptions.

Sulfometuron Methyl

There is no clear basis for suggesting that effects on terrestrial animals are likely or would be substantial. Adverse effects in mammals, birds, terrestrial insects, and microorganisms are not likely using typical or worst-case exposure assumptions at the typical application rate of 0.045 lb a.e./acre. The hazard quotients associated with the upper range for chronic consumption of vegetation by a large mammal (hazard quotient = 0.2) or large bird (hazard quotient = 0.3) feeding exclusively on treated vegetation slightly exceeds the level of concern of 0.1 associated with the maximum application rate of 0.38 lb a.e./acre. As with the human health risk assessment, this characterization of risk must be qualified. Sulfometuron methyl has been tested in only a limited number of species and under conditions that may not well-represent populations of free-ranging non-target species. Notwithstanding this limitation, the available data are sufficient to assert that no adverse effects are anticipated in terrestrial animals.

Triclopyr

For terrestrial mammals, the central estimates of hazard quotients do not exceed the level of concern for any exposure scenarios. At the upper range of exposures, the hazard quotients exceed the level of concern for large mammals and large birds consuming contaminated vegetation exclusively at the application site. At higher application rates, concern for exposure scenarios involving the consumption of

contaminated vegetation is augmented substantially. At the maximum application rate of 10 lbs a.e./acre, the central estimate of the hazard quotient exceed the level of concern for several acute exposure scenarios: the direct spray of a small mammal assuming 100% absorption, a large mammal consuming contaminated vegetation, and a small bird consuming contaminated insects. The central estimates of the hazard quotients for the chronic consumption of vegetation is exceeded for a large mammal and a large bird and the upper range on the hazard quotients are also increased by a factor of 10: i.e., to 60 for a large mammal and 50 for a large bird. This risk assessment is consistent with the risk characterization given by U.S. EPA indicating that contaminated vegetation is primary concern in the used of triclopyr and that high application rates will exceed the level of concern for both birds and mammals in longer term exposure scenarios.

Adjuvants / Surfactants

Based on a review of the current research, it would appear that adjuvants / surfactants have the potential to affect terrestrial insects. However, as is true with many toxicity issues, it would appear that any effect is dose related. The research does indicate that the silicone-based surfactants, because of their very effective spreading ability, may represent a risk of lethality through the physical effect of drowning, rather than through any toxicological effects. Silicone surfactants are typically used at relatively low rates and are not applied at high spray volumes because they are very effective surfactants. Hence it is unlikely that insects would be exposed to rates of application that could cause the effects noted in these studies. Other surfactants, which are less effective at reducing surface tension, can also cause the drowning effect. But as with the silicones, exposures have to be high, to the point of being unrealistically high, for such effects (Bakke 2002).

When considering the need for relatively high doses for a lethal effect, combined with the fact that individuals, not colonies or nests of invertebrates, may be affected, there is little chance that the surfactants could cause widespread effects to terrestrial invertebrates under normal operating conditions. Spills or accidents could result in concentrations sufficiently high to cause effects, depending upon the surfactant (Bakke 2002).

Use of ammonium sulfate (fertilizer adjuvant), when used as an herbicide on tall larkspur, will be done by spot treatment and used away from water per label instructions. Minimal effects to non-target organisms might occur, but generally only if an accidental spill occurred.

THREATENED / ENDANGERED SPECIES

Direct and Indirect Effects – Grizzly Bear

Grizzly Bear - Herbicide Toxicity, Alternative 1 (Proposed Action), Direct and Indirect Effects

This alternative proposes more acres of herbicide treatment than all other alternatives. Grizzly bears would be likely to occasionally contact herbicides by ingesting plants that had been sprayed and by dermal absorption following contact with sprayed plants. There is also a very small chance that grizzly bears could be directly sprayed with herbicide during aerial application. However, the toxicity of herbicides proposed for use is low, as are the chances of grizzly bears receiving doses great enough to cause toxic effects. However, this must be qualified by the fact that there is uncertainty regarding the toxicity of some herbicides and inert ingredients.

Grizzly Bear - Habitat Modification, Alternative 1 (Proposed Action), Direct and Indirect Effects

Compared to the No Change from Current Action - Alternative 3, more vegetation would be treated with herbicides. Therefore, there would be a larger short-term loss of forage resulting from mortality of non-target plants in treatment areas. However, native vegetation would begin to recover and provide forage within two to three years of herbicide treatment (Rice et al. 1997). Long-term impacts to grizzly bear spring foraging opportunities as weeds out-compete native vegetation would be lower than under the Alternative 3 (No Change from Current Action), because the acreage of untreated weed infestations would be smaller.

Grazing by goats and sheep in grizzly bear habitat to favor the growth of native plants would be used under this alternative. Grizzly bears could be attracted to and prey upon these animals. This could result in the conditioning of grizzly bears to livestock as food, and lead to conflicts with livestock on adjacent grazing allotments resulting in management removals of grizzly bears. However, goats and sheep would be used in localized areas. Bands of sheep and goats would be much smaller than those typically associated with commercial livestock grazing. Additionally, protection measures would be applied to lessen the chances of depredation conflicts developing. Herders and guard dogs would be used to monitor herds, and would immediately report any depredations. Electric fencing would be used to contain sheep and goats at night. Camps would be subject to the food storage order and herders required to dispose of any sheep or goat carcasses to prevent attracting bears. Sheep and goats would be removed from the Forest if grizzly bear depredations were to occur. Application of the above protection measures would ensure compliance with applicable Custer Forest Plan grizzly bear standards and guidelines. Use of goats and sheep for weed control under this alternative would also be in compliance with standards from the Final Conservation Strategy for Grizzly Bears in the Yellowstone Area (IGBC 2003) because grazing would be temporary and occur outside of any existing allotment, no new allotment would be created, and no animal months would be allocated.

Grizzly Bear - Disturbance and Displacement, Alternative 1 (Proposed Action), Direct and Indirect Effects

The potential for disturbance or displacement of grizzly bears would be great since more weeds would be treated with ground based applications and there would be an additional chance of displacing bears with aerial spraying. No aerial spraying is currently proposed within grizzly bear core habitat, although the need for this activity may arise in the future. Aerial spraying of a weed population would occur once per year, and would be completed in several hours or less. Protection measures would be applied to allow only 8 hours of aerial spraying within core habitat per Bear Management Sub-unit per year in order to limit disturbance within this important habitat. This would be consistent with core habitat management direction from Forest Plan and the Conservation Strategy, because there would be no reduction in core habitat and there would be no reoccurring low-level helicopter flights over core habitat.

Grizzly Bear - Herbicide Toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 2 (No Herbicides), Direct and Indirect Effects

There would be no toxic effects to grizzly bears under this alternative because no herbicides would be used.

Under this alternative there would be no short-term loss of grizzly bear forage resulting from non-target plants killed by herbicides, because no herbicides would be used. Instead, the long-term availability of native forage plants would be reduced as they are out-competed by weeds.

The effects of sheep and goat grazing for weed management on grizzly bears would be similar under all alternatives. Their effects are described in detail under Alternative 1.

Disturbance and displacement of grizzly bears under this alternative would be minimal. Mechanical and herbicide treatments require the most human activity and have the most potential to cause disturbance. No herbicide treatment and very limited amounts of mechanical treatment would be used under this alternative.

Grizzly Bear - Herbicide toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 3 (No Change from Current Management), Direct and Indirect Effects

Grizzly bears would be likely to occasionally contact herbicides by ingesting plants that had been sprayed and by dermal absorption following contact with sprayed plants. The toxicity of herbicides proposed for use is low, along with the chances of grizzly bears receiving doses great enough to cause toxic effects. However, this must be qualified by the fact that there is uncertainty regarding the toxicity of some herbicides and inert ingredients.

Under this alternative, grizzly bear habitat would be treated with herbicides each year. These areas would have reduced foraging capacity for grizzly bears because non-target plants would be killed by broad-spectrum herbicides until native vegetation began recovering within 2-3 years of herbicide treatment (Rice et al. 1997). Weed infestations are most likely to occur in association with roads or other human developments, while grizzly bears tend to avoid those same disturbances (IGBC 1998). Despite this potential spatial separation, it is highly likely that grizzly bears use areas with weed infestations to some degree. However, many weed infestations would not be treated, and they would continue to spread and displace native forage plants (especially in lower-elevation sagebrush/grassland habitat types). Grizzly bears forage in these areas primarily during spring or early summer when green plants are emerging but higher-elevation habitats are still snow-covered (USFWS 1993). The long-term availability of spring forage for grizzly bears would be somewhat reduced by the continued spread of weeds. Other important grizzly bear habitat includes avalanche chutes, high elevation meadows, and whitebark pine stands that would be largely unaffected since they are at low risk for weed infestations. The effects of sheep and goat grazing for weed management on grizzly bears would be similar under all alternatives. Their effects are described in detail under Alternative 1.

It is likely that grizzly bears would occasionally be displaced as a result of weed treatment activities. However, activities such as herbicide spraying and grubbing would be of short duration in any given spot, so any displacement would be localized and last only a few days. Bears could resume use of treated areas shortly thereafter.

Cumulative Effects – Grizzly Bear

Grizzly Bear – Alternative 1 (Proposed Action) – Cumulative Effects

Cumulative effects to grizzly bears resulting from herbicide use in this alternative would be similar to those described under Alternative 3 (No Action), because the herbicides proposed for use are rapidly excreted and do not bio-accumulate. Weed control activities would not alter access values and impacts to grizzly bear core habitat from aerial spraying would be mitigated, therefore any disturbance to grizzly bears resulting from this alternative would not contribute to cumulative effects on grizzly bears. This alternative would have a greater probability of containing the spread of weeds than the others and would have the least cumulative effects on grizzly bear foraging opportunities.

Grizzly bear – Alternative 2 (No Herbicides) – Cumulative Effects

No herbicides would be used, so there would be no cumulative toxic effects. Weed control activities would not impact core areas or alter other access values, so any disturbance to grizzly bears resulting from this alternative would have discountable cumulative effects. This alternative would have a lower probability of containing the spread of weeds than all others and would do the least to preserve grizzly bear foraging opportunities. It would therefore have more cumulative effects than other alternatives.

Grizzly bear – Alternative 3 (No Change from Current Management) – Cumulative Effects

Cumulative effects to grizzly bears were analyzed for the two Bear Management Subunits on the Custer National Forest (Boulder Slough #1 and Lamar #1), because Bear Management Subunits are approximately the average size of a female grizzly bear's home range and contain all necessary seasonal habitat components. The temporal bounds for the analysis were the past 10 years and 15 years into the future, because weed infestations have changed rapidly and it is difficult to predict how their spread beyond that timeframe would affect grizzly bear habitat.

Weed control with herbicides is an activity that has been occurring for years in the analysis area, and undoubtedly will continue for many years into the future. Private landowners, county governments, and other state and federal agencies all use herbicides to control weeds. However, this use has been compatible with grizzly bear recovery and is expected to continue to be so. The herbicides proposed for use are water-soluble and do not bio-magnify, so cumulative toxic effects to grizzly bears resulting from these processes would not occur.

A large variety of human activities occur in the analysis area, many of which may disturb or displace grizzly bears. Grizzly bear access management in the recovery zone is designed to balance these effects by providing core habitat characterized by a low level of human activity that could cause disturbance to bears. The analysis area was 110,500 acres, and all but approximately 1,200 acres of this was secure habitat. The amount of secure habitat in these Bear Management Subunits was deemed adequate, because at least that much was present in 1998 when the grizzly bear population achieved recovery goals (IGBS 2003). Aerial spraying in core habitat could temporarily displace grizzly bears from localized areas. However, cumulative effects resulting from such actions would be discountable, due to their short duration and localized nature. Adjacent areas of core habitat would continue to be managed to provide secure grizzly bear habitat.

Threats to several major grizzly bear food sources in the analysis area have been documented. The long-term persistence of whitebark pine trees, whose nuts provide a critical seasonal food source for grizzly bears (Felicetti et al. 2003), is threatened by blister rust, mountain pine beetle attack, and climate change (Tomback et al. 2001). Increased development of private lands may decrease habitat availability for ungulate populations, which are more important to bears in the Yellowstone area than to other grizzly populations (IGBC 2003).

Bears may be forced to rely more on herbaceous vegetation if these food sources decline in the future. Weeds have not been implicated as a major threat to grizzly bear forage, but the potential does exist for this to become more of an issue in the future if weeds spread into core habitat and other areas with low access densities that are preferred grizzly bear habitat. Although there is uncertainty regarding the ultimate impacts of weeds on grizzly bear foraging opportunities in the analysis area over the long-term, it is likely that over the next 15 years weeds would not have a major impact due to the broad diets of bears and the current low amount of weed infestation in the most important bear habitats. Forest Service projects such as timber sales and prescribed fires, road maintenance, recreational activities and vehicle use, special use permits (both recreation events and non-recreation), livestock grazing, and summer home residence may contribute to the spread of weeds. Recently adopted Best Management Practices (Forest Service Manual 2080) for preventing weed spread are incorporated as protection measures in project plans, which would help limit weed spread from Forest Service actions. Therefore, even though this alternative would be insufficient to contain the spread of most weed infestations, cumulative impacts to grizzly bear foraging opportunities would be low.

Direct and Indirect Effects – Gray Wolf

Gray Wolf - Herbicide Toxicity, Alternative 1 (Proposed Action), Direct and Indirect Effects

Wolves would be likely to occasionally contact herbicides by dermal absorption following contact with sprayed plants. There is also a very small chance that they could be directly sprayed with herbicide during aerial application. However, the toxicity of herbicides proposed for use is low (Table 3-14). Although there is uncertainty involved with the toxicity of some herbicides and inert ingredients, the chances of wolves receiving doses great enough to cause toxic effects are very low.

Gray Wolf - Habitat Modification, Alternative 1 (Proposed Action), Direct and Indirect Effects

Under this alternative, fewer acres of weed infestations would go untreated compared to all other alternatives. Elk populations, which are the primary prey for wolves, are not currently limited by weed infestations so short-term effects on wolves would be similar to the Alternative 3 (No Change from Current Action). The long term effects of weed infestations on elk populations are uncertain, but this alternative would do the most to maintain forage for the prey populations that wolves are dependent on.

As with grizzly bears, the use of sheep and goats for weed management could lead to possible conflicts with wolves. Wolf depredation can be a problem when commercial sheep grazing operations are located in proximity to areas occupied by wolves (USFWS 1987). This could lead to conditioning of wolves to livestock as food, and lead to conflicts with livestock on adjacent grazing allotments resulting in management removals of wolves. However, the grazing use proposed in this alternative differs from typical commercial grazing operations in several key ways that would reduce the likelihood of this occurring.

Goats and sheep would be used in localized areas. Bands of sheep and goats would be much smaller than those typically associated with commercial livestock grazing. Additionally, protection measures would be applied to lessen the chances of depredation conflicts developing. Herders and guard dogs would be used to monitor herds, and would immediately report any losses of their stock. Herders would be required to immediately dispose of any sheep or goat carcasses to prevent attracting wolves, receive training from the U.S. Fish and Wildlife Service or other authorized organization in the use of hazing techniques to prevent depredations by wolves, and to implement those techniques when wolves are known to be in proximity to domestic sheep or goats being used for weed control. Electric fencing would be used to contain sheep and goats at night. Sheep and goats would be removed from the Forest if wolf depredations were to occur. Despite such precautions, wolves have preyed upon domestic sheep being used for weed control in the Yellowstone area (Bangs 2003) with resulting management removal of a wolf, and there is potential for this to occur on the Forest if goats or sheep are used.

Gray Wolf - Disturbance and Displacement, Alternative 1 (Proposed Action), Direct and Indirect Effects

Wolves could be displaced by activities such as ground-based herbicide spraying. However, activities would be of relatively short duration during daylight hours, so disturbance or displacement would be very temporary and affect only localized areas. Aerial spraying would be more likely to disturb or displace wolves than ground spraying, but the additive disturbance of this treatment on wolves would be discountable due to the short duration and localized nature of aerial spraying. Based on wolf protection measures, weed treatment activities would not disturb wolf denning because no ground-based or aerial spraying would occur within ½ mile of a known den site from April 1 thru June 30 (J. Trapp, MT Fish, Wildlife, and Parks, personal communication on 04/29/05).

Gray Wolf - Herbicide Toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 2 (No Herbicides), Direct and Indirect Effects

There would be no toxic effects to gray wolves under this alternative because no herbicides would be used.

The effects of sheep and goat grazing for weed management on wolves would be similar under all alternatives. Their effects are described in detail under Alternative 1.

Long-term negative impacts to elk forage and ultimately the prey base for wolves would be uncertain, but potentially greater for this alternative than all others because the treatments proposed would be the least likely to contain the spread of weeds.

Although weed management activities would vary among alternatives, they would have similar displacement and disturbance effects on wolves. These effects are described in detail in Alternative 1, and are expected to be discountable due to their short duration and localized nature.

Gray Wolf - Herbicide Toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 3 (No Change from Current Management), Direct and Indirect Effects

Wolves would occasionally come into contact with herbicides through dermal absorption following contact with treated vegetation. Due to the low toxicity of herbicides proposed for use and the low doses expected with dermal absorption, toxic effects to wolves would be extremely unlikely even with the uncertainty involved regarding the toxicity of some herbicides and inert ingredients.

The acreage of weed treatment would be insufficient to contain the spread of weeds. Elk winter ranges are generally in low-to-mid elevation rangelands that have a high risk for infestation by weeds. Degradation of elk winter ranges on the Forest due to weed infestation would likely lead to lower populations of prey for wolves. The effects of sheep and goat grazing for weed management on wolves would be similar under all alternatives. Their effects are described in detail under Alternative 1.

Although weed management activities would vary among alternatives, they would have similar displacement and disturbance effects on wolves. These effects are described in detail in Alternative 1, and are expected to be discountable due to their short duration and localized nature.

Cumulative Effects – Gray Wolf

Gray Wolf – Alternative 1 (Proposed Action) – Cumulative Effects

Cumulative effects to wolves resulting from herbicide use in this alternative would be similar to those described under Alternative 3 (No Action), because of the low potential for herbicides proposed for use to bio-magnify. Weed control activities would not impact dens, and any disturbance to wolves resulting from this alternative would have discountable cumulative effects. This alternative would have the greatest probability of containing the spread of weeds, and would do the most to preserve elk and deer populations that provide the forage base for wolves. It would have the least cumulative effects on wolves.

Gray Wolf – Alternative 2 (No Herbicides) – Cumulative Effects

No herbicides would be used, so there would be no cumulative toxic effects. The potential for disturbance and displacement would be lowest under this alternative, and would have discountable cumulative effects. This alternative would be more likely to contribute to cumulative effects on wolves than Alternative 3 (No Action), because it would be less likely to contain the spread of weeds in elk habitat over the next 15 years and lower elk populations could result.

Gray Wolf – Alternative 3 (No Change from Current Management) – Cumulative Effects

Cumulative effects to gray wolves were analyzed for the Absaroka Elk Management Unit (EMU), which contains all seasonal ranges for elk on the Custer National Forest within known wolf distribution. EMU's were delineated in the Statewide Elk Management Plan for Montana as a collection of hunting districts that share similar ecological conditions and encompass the yearlong range of major elk populations (Youmans 1992). They were used because elk populations are the primary factor determining wolf distribution on the Forest. The temporal bounds for the analysis were the past 10 years and 15 years into the future. Because weed infestations have changed rapidly and it is difficult to predict how they will spread beyond that timeframe, it will also be difficult to predict how weeds would affect wolves and their prey.

Weed control with herbicides is an activity that has been occurring for years in the analysis area, and undoubtedly will continue for many years into the future. Private landowners, county governments, and other state and federal agencies all use herbicides to control weeds. However, this use has been compatible with wolf recovery and is expected to continue to be so in the future. The herbicides proposed for use are water-soluble and do not bio-magnify, so cumulative toxic effects to wolves under this alternative would not occur.

A large variety of human activities occur in the analysis area. Isolated cases of disturbance to wolf dens from human activity have occurred in the past (Smith 1998), but have not affected wolf recovery. Disturbance or displacement of wolves under this alternative would be infrequent and have discountable cumulative effects to wolves.

Elk populations, which provide the bulk of the forage base for wolves in the analysis area, are generally robust. Private land development is probably the main threat to elk populations, but public land winter range is also available. The quality of public lands winter ranges may become more important in the future, as private lands winter ranges are lost to development. The continued spread of weeds on elk winter ranges could decrease forage availability and ultimately elk populations within the next 15 years. This alternative could contribute to cumulative effects on wolves because it may not be sufficient to contain the spread of weeds in important elk habitat, and lower elk populations could result.

Other Forest Service projects such as timber sales and prescribed fires, road maintenance, recreational activities and vehicle use, special use permits (both recreation events and non-recreation), livestock grazing, and summer home residence may contribute to the spread of weeds in winter range areas. Recently adopted Best Management Practices (Forest Service Manual 2080) for preventing weed spread

are incorporated as protection measures in project plans, which would help limit weed spread from Forest Service actions.

Direct and Indirect Effects – Bald Eagle

Bald Eagle - Herbicide Toxicity, Alternative 1 (Proposed Action), Direct and Indirect Effects

Since bald eagles are not currently known to nest on the Forest they would be highly unlikely to come into contact with herbicides on the Forest. Foraging bald eagles from off-forest nest locations could possibly come into contact with treated areas. This section will discuss the potential affects on bald eagles from adjacent lands or if nests are found on the Forest in the future. No aerial spraying would be allowed within 800 meters if an active bald eagle nest was located, which would prevent the direct spraying of adult birds or chicks on their nests. The chances of bald eagles being directly sprayed would otherwise be very remote. The amount of herbicide absorbed would be very low, and toxic effects would be unlikely due to the low toxicity of herbicides proposed for use. However, this must be qualified by the fact that there is uncertainty regarding the toxicity of some herbicides and inert ingredients. The herbicides proposed for use do not appear to bio-accumulate or bio-magnify, so the probability of toxic effects to eagles resulting from them eating contaminated prey would also be very low.

Bald Eagle - Habitat Modification, Alternative 1 (Proposed Action), Direct and Indirect Effects

Weed infestations and treatments proposed under this alternative would have little affect upon potential bald eagle habitat. Weeds have not affected the aquatic systems that support the major fish populations on the Forest, Mystic, West Rosebud, and East Rosebud Lakes that in turn would provide the majority of forage for breeding bald eagles on the Forest. Fish populations in the major water bodies that would be the most important to bald eagles would not be affected by herbicide use because protection measures would be applied to protect aquatic species (see Fisheries/Amphibians specialist's report) and the large volume of water in these lakes would dilute any herbicides that entered the system to non-toxic levels.

Bald Eagle - Disturbance And Displacement, Alternative 1 (Proposed Action), Direct and Indirect Effects

Because of the high potential for disturbance to nesting eagles from aerial spraying, protection measures would be applied preventing aerial spraying within zones I or II (less than 800 meters) of bald eagle nests. Ground-based human activities associated with the project would not be allowed within zone I (less than 400 meters) of an active nest, except along roadways open to public motorized use where disturbance already occurs. These measures would be in compliance with recommendations for bald eagle nesting territory management (Greater Yellowstone Bald Eagle Working Group 1996) and would effectively prevent disturbance of nesting eagles. Project activities could otherwise lead to the occasional disturbance and displacement of foraging eagles, but these effects would normally be discountable due to the localized nature of treatments and the availability of alternative foraging locations.

Bald Eagle - Herbicide Toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 2 (No Herbicides), Direct and Indirect Effects

There would be no toxic effects to bald eagles under this alternative because no herbicides would be used.

Impacts to bald eagle habitat would be very similar under all alternatives. The effects are described in detail under Alternative 1. The only difference is that elk populations could be lower under this alternative, possibly leading to reduced availability of carrion for eagles.

The potential for disturbance or displacement of foraging bald eagles would be very low because biocontrol would be the treatment method affecting the most acres. Little human activity is associated with biocontrol. Mechanical and herbicide treatments require the most human activity and have the most potential to cause disturbance. No herbicide treatment and very limited amounts of mechanical treatment would be used under this alternative.

Bald Eagle - Herbicide Toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 3(No Change from Current Management), Direct and Indirect Effects

The effects of this alternative would similar to those described in Alternative 1, except that there would be a lower chance of bald eagles contacting herbicides due to the lower number of acres proposed for treatment.

Impacts to bald eagle habitat would be very similar under all alternatives. The effects are described in detail under Alternative 1. The difference is that elk populations could be lower under this alternative, possibly leading to reduced availability of carrion for eagles.

The potential for disturbance and displacement of bald eagles would be lower than under Alternative 1, because no aerial spraying would occur and fewer acres would be treated using ground-based activities. Bald eagles could be disturbed or displaced by weed control activities, especially by ground-based herbicide spraying near active nests. The same protection measures would apply to ground-based weed management activities to prevent disturbance of nesting eagles.

Cumulative Effects – Bald Eagle

Bald Eagle – Alternative 1 (Proposed Action) – Cumulative Effects

Cumulative effects to eagles resulting from herbicide use in this alternative would be similar to those described under Alternative 3 (No Action), because the herbicides proposed for use are rapidly excreted and do not bio-accumulate. Cumulative impacts of disturbance to foraging eagles resulting from this alternative would be slightly greater than under the No Action Alternative. However, these effects would be very slight due to the short duration and localized nature of the proposed treatments. As for the No Action Alternative, there would be no cumulative effects to bald eagle forage or their habitat.

Bald Eagle – Alternative 2 (No Herbicides) – Cumulative Effects

No herbicides would be used, so there would be no cumulative toxic effects. The potential for disturbance and displacement of eagles would be minimal under this alternative, and would have discountable cumulative effects because alternate foraging areas would still be available. This alternative would have no direct or indirect effect upon the forage base for eagles or their habitat, and would not have any cumulative effect.

Bald Eagle – Alternative 3 (No Change from Current Management) – Cumulative Effects

The analysis area for bald eagles was the Beartooth Mountains portion of the Beartooth Ranger District because this area would be the most likely location on the forest for future nesting bald eagles. The temporal bounds for the analysis were the past 10 years and 15 years into the future, because weed infestations have changed rapidly and it is difficult to predict how their spread beyond that timeframe would affect eagles.

Weed control with herbicides is an activity that has been occurring for years in the analysis area, and undoubtedly will continue for many years into the future. Private landowners, county governments, and other state and federal agencies all use herbicides to control weeds. Other pesticides including organophosphates and carbamates are also in use and have caused bald eagle mortalities on the Gallatin National Forest which is adjacent to the Custer National Forest in the Beartooth Mountains (Greater Yellowstone Bald Eagle Working Group 1996). However, the herbicides proposed for use are water-soluble and do not bio-magnify. Therefore, no toxic cumulative effects to bald eagles are expected under this alternative.

A large variety of human activities occur in the analysis area. The human population in the analysis area is growing rapidly. The potential for disturbance and displacement of eagles has therefore also increased. Although private land eagle habitat may be affected more, recreational use of public lands will also continue to cause disturbance problems for eagles in the future. Disturbance to nesting bald eagles would largely be mitigated under this alternative. There would be some cumulative effects to foraging bald

eagles that were displaced due to weed control activities under this alternative, because birds would be displaced to other areas that would likely have human activities such as fishing and boating. They could also be discouraged from foraging in these areas. Recreational activities are currently not high enough to prevent bald eagles from finding adequate forage, but could increase to that level within the next 15 years. However, the disturbance and displacement of foraging eagles resulting from this alternative would be discountable because of effective protection measures, and the localized, short duration nature of activities.

This alternative would have no direct or indirect effect upon the forage base for eagles or their habitat, and would therefore not have any cumulative effect.

Sensitive Species

Sensitive Species - Herbicide Toxicity, Alternative 1 (Proposed Action), Direct and Indirect Effects

The probability would be greater for this alternative than for all other alternatives that sensitive species including the peregrine falcon, northern goshawk, Baird's sparrow, blue-gray gnatcatcher, burrowing owl, greater sage grouse loggerhead shrike, long-earred myotis, long-legged myotis, pallid bat, spotted bat, and Townsend's big-eared bat would contact herbicides. The only expected overlap between wolverine habitat and treatment areas would be on big-game winter ranges. However, wolverines would not be expected to contact herbicides because they use big game winter ranges while carrion is available during the winter and early spring, before herbicides would be used. Black-tailed and white-tailed prairie dog colonies located on the Forest are presently weed free. Toxic effects to sensitive species due to the use of herbicides under this alternative are unlikely. Species such as the peregrine falcon, northern goshawk, Baird's sparrow, blue-gray gnatcatcher, burrowing owl, greater sage grouse, loggerhead shrike, long-earred myotis, long-legged myotis, pallid bat, spotted bat, and Townsend's big-eared bat could occasionally ingest prey that had been sprayed with herbicides because they forage in areas that may receive treatment with herbicide. The herbicides proposed for use have not been found to bio-accumulate or bio-magnify. The toxicity of herbicides proposed for use is low (Table 3-14), as is the chance of these species receiving doses great enough to cause toxic effects. However, this must be qualified by the fact that there is uncertainty regarding the toxicity of some herbicides and inert ingredients.

Sensitive Species - Habitat Modification, Alternative 1 (Proposed Action), Direct and Indirect Effects

The short-term impacts of herbicides on vegetation could cause localized decreases in the abundance of prey species for peregrine falcon, northern goshawk, Baird's sparrow, blue-gray gnatcatcher, burrowing owl, greater sage grouse, loggerhead shrike, long-earred myotis, long-legged myotis, pallid bat, spotted bat, and Townsend's big-eared bat. These impacts would be more widespread than those under Alternative 3 (No Change from Current Action), due to the much larger area proposed for treatment. However, populations of these prey species depend on native vegetation and would begin recovering in treated areas within 2-3 years of herbicide treatment (Rice *et al.*, 1997). This alternative would result in more acres of weed infestation successfully treated compared to the Alternative 3, and the long-term availability of forage for these species would be improved.

Sensitive Species – Disturbance and Displacement, Alternative 1 (Proposed Action), Direct and Indirect Effects

The probability of disturbance and displacement of sensitive species under this alternative would be slightly larger than for all other alternatives, due to the use of aerial spraying. The effects would be temporary and localized due to the short duration of aerial spraying. Breeding activities of sensitive species would not be affected because weed control would generally not occur in close proximity to expected nesting and breeding areas for species that are sensitive to disturbance such as peregrine falcons and goshawks. Aerial spraying would not occur within one mile of known peregrine nests and within ¼ of goshawk nests. With protection measures that prohibit aerial spraying less than one mile of an active peregrine falcon nest from April 1-August 15 and within ¼ mile of an active goshawk nest from April 1 to August 15, this alternative would be consistent with management recommendations for this species

because other weed management activities would be within the scope of activities that historically occurred.

Sensitive Species - Herbicide Toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 2 (No Herbicides), Direct and Indirect Effects

There would be no toxic effects to sensitive species under this alternative because no herbicides would be used.

The short-term impacts of weed treatment on forage availability for peregrine falcon, northern goshawk, Baird's sparrow, blue-gray gnatcatcher, burrowing owl, greater sage grouse, loggerhead shrike, long-earred myotis, long-legged myotis, pallid bat, spotted bat, and Townsend's big-eared bat would be less than under all other alternatives because biocontrol using species-specific agents rather than broad-spectrum herbicides that kill a variety of plants would be the most widespread treatment method. Long-term negative effects of this alternative to sensitive species habitat would be greater than those expected under the Alternative 3 (No Action), because weed treatments would be less likely to contain the spread of weeds.

The potential for disturbance or displacement of sensitive species would be very low because biological control would be the treatment method affecting the most acres. Little human activity is associated with biological control.

Sensitive Species - Herbicide Toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 3 (No Change from Current Management), Direct and Indirect Effects

The effects of this alternative would similar to those described in Alternative 1, except that there would be a lower chance of sensitive species contacting herbicides due to the lower number of acres proposed for treatment and the lack of aerial spraying.

The short-term effects of this alternative upon sensitive species habitat would be similar to those described under Alternative 1, except they would be less widespread due to the much smaller area proposed for treatment. Over the long term, forage availability for these species would decline because the amount of acreage treated would be insufficient to limit the spread of weed infestations.

The probability of disturbance and displacement of sensitive species under this alternative would be smaller than under Alternative 1, due to the lower number of acres proposed for treatment and the lack of aerial spraying. Some disturbance and displacement of sensitive species could still result from weed treatments, but the effects would be temporary and localized. As described in Alternative 1, protection measures would be applied to prevent disturbance to breeding goshawks.

Sensitive Species - Cumulative Effects

Sensitive Species - Cumulative Effects - Alternative 1 (Proposed Action)

Cumulative effects to sensitive species resulting from herbicide use in this alternative would be similar to those described under Alternative 3 (No Action), because the herbicides proposed for use are rapidly excreted and do not bio-accumulate. Cumulative effects resulting from disturbance would be slightly greater than other alternatives due to the larger area of treatment proposed, but would still have minimal impacts. This alternative would have the greatest probability of containing the spread of weeds, and would do the most to maintain suitable native vegetation that provides habitat for sensitive species. Cumulative impacts on sensitive species habitat over the next 15 years would be lowest under this alternative.

Sensitive Species - Cumulative Effects - Alternative 2 (No Herbicides)

No herbicides would be used, so there would be no cumulative toxic effects. Disturbance from weed treatment activities proposed under this alternative would have the least cumulative effects on sensitive species because it would involve the fewest activities with the potential to cause disturbance. This alternative would contribute more to cumulative effects on sensitive species habitat than all other

alternatives because it would be the least likely to contain the spread of weeds and continued habitat degradation would result over the next 15 years.

Sensitive Species - Cumulative Effects - Alternative 3 (No Change from Current Management)

The analysis area for sensitive species was Beartooth, Ashland and Sioux Ranger Districts. This area was chosen because it is a large area that provides a full variety of the habitats available to the wolverine, peregrine falcon, northern goshawk, Baird's sparrow, blue-gray gnatcatcher, burrowing owl, greater sage grouse, loggerhead shrike, long-earred myotis, long-legged myotis, pallid bat, spotted bat, Townsend's big-eared bat, black-tailed prairie dog and white-tailed prairie dog in southeast Montana. The temporal bounds for the analysis were the past 10 years and 15 years into the future, because weed infestations have changed rapidly and it is difficult to predict how their spread beyond that timeframe would affect sensitive species habitat.

Weed control with herbicides is an activity that has been occurring for years in the analysis area, and undoubtedly will continue for many years into the future. Private landowners, county governments, and other state and federal agencies all use herbicides to control weeds. However, the herbicides proposed for use are water-soluble and do not bio-accumulate. Although they may occasionally contact herbicides, no toxic cumulative effects to the wolverine, peregrine falcon, northern goshawk, Baird's sparrow, blue-gray gnatcatcher, burrowing owl, greater sage grouse, loggerhead shrike, long-earred myotis, long-legged myotis, pallid bat, spotted bat, Townsend's big-eared bat, black-tailed prairie dog and white-tailed prairie dog are expected under this alternative.

The continued spread of weeds on other public and private lands would lead to loss of native vegetation that supports prey populations for the wolverine, peregrine falcon, northern goshawk, Baird's sparrow, blue-gray gnatcatcher, burrowing owl, greater sage grouse, loggerhead shrike, long-earred myotis, long-legged myotis, pallid bat, spotted bat, Townsend's big-eared bat, black-tailed prairie dog and whit-tailed prairie dog. Forest Service projects such as timber sales and prescribed fires, road maintenance, recreational activities and vehicle use, special use permits (both recreation events and non-recreation), livestock grazing, and summer home residence may contribute to the spread of weeds. Recently adopted Best Management Practices (Forest Service Manual 2080) for preventing weed spread are incorporated as protection measures in project plans, which would help limit weed spread from Forest Service actions. This alternative would contribute somewhat to cumulative effects on these species because it would be insufficient to contain most weed infestations and continued habitat degradation would result, although the degree to which populations of sensitive species would be impacted is difficult to predict.

Disturbance from human activities has been identified as a problem for some sensitive species, such as the western big-eared bat (Reel et al. 1989). Although a variety of sensitive species are subject to disturbance from human activities, the impacts of these effects are unknown. Disturbance from weed treatment activities proposed under this alternative would have very low cumulative effects on sensitive species due to the very small area that would be treated compared to the large area subject to disturbance by other human activities.

Management Indicator Species / Key Species

Management Indicator Species / Key Species - Herbicide Toxicity, Alternative 1 (Proposed Action), Direct and Indirect Effects

The chances of MIS/Key Species, goshawk, white-tailed deer, ruffed grouse, western kingbird, Bullock's oriole, yellow warbler, ovenbird, spotted towhee, Brewer's sparrow, sharp-tailed grouse, elk, golden eagle, merlin, mule deer, bighorn sheep, and pronghorn antelope, contacting herbicides would be greater under this alternative than for all other alternatives, because this alternative proposed the most herbicide use. Most herbicide use would occur in habitats occupied by MIS/Key Species, and they would be likely to occasionally ingest sprayed vegetation or prey species (insects) that had been sprayed. There would be a small additional risk of MIS/Key Species being directly sprayed during aerial herbicide application. The toxicity of herbicides proposed for use is low, as are the chances of MIS/Key Species receiving doses great enough to cause toxic effects. However, this must be qualified by the fact that there is uncertainty regarding the toxicity of some herbicides and inert ingredients.

Management Indicator Species / Key Species - Habitat Modification, Alternative 1 (Proposed Action), Direct and Indirect Effects

This alternative would involve the greatest short-term impacts but also the most long-term benefits to MIS/Key Species populations, because this alternative proposed the most acreage of weed treatment. Forage and habitat availability would temporarily decrease in areas treated with herbicides, but would begin recovering within two to three years of herbicide treatment (Rice et al. 1997). Over the long term, fewer acres of weeds would go untreated under this alternative than for all others.

Management Indicator Species / Key Species - Disturbance and Displacement, Alternative 1 (Proposed Action), Direct and Indirect Effects

The probability of disturbance and displacement of MIS/Key Species under this alternative would be slightly larger due to the use of aerial spraying. The effects would still be temporary and localized due to the short duration of aerial spraying.

Management Indicator Species / Key Species - Herbicide Toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 2 (No Herbicides), Direct and Indirect Effects

There would be no toxic effects to MIS / Key Species under this alternative because no herbicides would be used.

The short-term effects to MIS/Key Species habitat would be less than under all other alternatives because biocontrol using species-specific agents rather than broad-spectrum herbicides that kill a variety of plants would be the most widespread treatment method. Long-term negative impacts to MIS/Key Species habitat would be greater for this alternative than all others, because the treatments proposed would be the least likely to contain the spread of weeds.

The potential for disturbance or displacement of MIS/Key Species would be very low because biological control would be the treatment method affecting the most acres. Little human activity is associated with biological control.

Management Indicator Species / Key Species, Herbicide Toxicity, Habitat Modification, and Disturbance and Displacement, Alternative 3 (No Change from Current Management), Direct and Indirect Effects

The chances of MIS/Key Species contacting herbicide would be lower than under Alternative 1, because the number of acres treated would be lower. The chances of MIS/Key Species experiencing toxic effects if they did contact herbicides are low, and are described in detail under Alternative 1.

Under this alternative, there would be a smaller short-term loss of MIS/Key Species forage in areas treated with herbicides until native vegetation began recovering within 2-3 years of herbicide treatment (Rice et al. 1997) compared to Alternative 1. Degradation of MIS/Key Species habitat on the Forest would likely lead to lower long-term MIS/Key Species populations compared to Alternative 1, because the treatments proposed would less effective at containing the spread of weeds.

Some disturbance and displacement of MIS/Key Species would be expected to result from weed treatments. These effects would be temporary and localized, and adjacent areas would normally contain suitable habitat for displaced animals.

Management Indicator Species / Key Species - Cumulative Effects

Management Indicator Species / Key Species, Cumulative Effects - Alternative 1 (Proposed Action)

Cumulative effects to MIS/Key Species resulting from herbicide use in this alternative would be similar to those described under Alternative 3 (No Action), because the herbicides proposed for use are rapidly excreted and do not bio-accumulate. Cumulative effects resulting from disturbance would be slightly

greater than other alternatives due to the larger area of treatment proposed, but would still have minimal impacts. This alternative would have the greatest probability of containing the spread of weeds, and would do the most to maintain quality MIS/Key Species habitat within the analysis area. Cumulative impacts on MIS/Key Species habitats over the next 15 years would be lowest under this alternative.

Management Indicator Species / Key Species, Cumulative Effects - Alternative 2 (No Herbicides)

No herbicides would be used, so there would be no cumulative toxic effects. The potential for disturbance and displacement of MIS/Key Species would be minimal and contribute the least towards cumulative effects on MIS/Key Species compared to all other alternatives. This alternative would contribute more towards cumulative effects on MIS/Key Species habitat than all other alternatives because it would be the least likely to contain the spread of weeds in MIS/Key Species habitats.

Management Indicator Species / Key Species, Cumulative Effects - Alternative 3 (No Change from Current Management)

The analysis area for MIS/Key Species was the Beartooth, Ashland and Sioux Ranger Districts. This area was chosen because it is a large area that provides a full variety of the habitats available to the MIS/Key Species on the Custer National Forest. The temporal bounds for the analysis were the past 10 years and 15 years into the future, because weed infestations have changed rapidly and it is difficult to predict how weed spread beyond that timeframe would affect MIS/Key Species habitat.

Weed control with herbicides is an activity that has been occurring for years in the analysis area, and undoubtedly will continue for many years into the future. Private landowners, county governments, and other state and federal agencies all use herbicides to control weeds. However, toxic effects to MIS/Key Species associated with this use have not been identified. The herbicides proposed for use are water-soluble and do not bio-accumulate, so cumulative toxic effects to MIS/Key Species resulting from bio-accumulation under this alternative would not occur.

A large variety of human activities occur in the analysis area, many of which have the potential to disturb or displace MIS/Key Species. Disturbance from weed treatment activities proposed under this alternative would have very low cumulative effects on MIS/Key Species due to the small number of acres that would be treated compared to the large area subject to disturbance by other human activities.

MIS/Key Species populations are generally robust in the analysis area. Private land development is probably the main threat. The quality of MIS/Key Species habitat available in public lands may become more important in the future as private lands are lost to development. Forest Service projects such as timber sales and prescribed fires, road maintenance, recreational activities and vehicle use, special use permits (both recreation events and non-recreation), livestock grazing, and summer home residence may contribute to the spread of weeds. The continued spread of weeds on MIS/Key Species habitats will likely decrease habitat availability and ultimately MIS/Key Species populations in the future. Recently adopted Best Management Practices (Forest Service Manual 2080) for preventing weed spread are incorporated as protection measures in project plans, which would help limit weed spread from Forest Service actions. The continued spread of weeds on MIS/Key Species habitats could contribute to cumulative effects on MIS/Key Species.

SUMMARY OF EFFECTS ON WILDLIFE

Table 4 – 20 summarizes the potential risk of toxic effects to wildlife by alternative.

TABLE 4 - 20. POTENTIAL RISK OF TOXIC EFFECTS TO WILDLIFE

	Alt. 1-Proposed Action	Alt. 2–No herbicides	Alt. 3-No Action
Grizzly Bear	Low[42]	None	Low
Gray Wolf	Low	None	Low

[42] Low risk means that animals may contact herbicides but are unlikely to experience toxic effects due to the low toxicity of herbicides proposed for use. No risk means that animals would not contact herbicide.

	Alt. 1-Proposed Action	Alt. 2–No herbicides	Alt. 3-No Action
Bald Eagle	Low	None	Low
Sensitive Species[43]	Low	None	Low
MIS/Key Species[44]	Low	None	Low

Table 4 – 21 summarizes the potential effects weed management alternatives on wildlife habitat under each of the alternatives. Effects were a combination of short-term impacts of the treatments versus the long-term impacts of invasive weeds.

TABLE 4 - 21. POTENTIAL EFFECTS ON WILDLIFE HABITAT BY ALTERNATIVE

	Alt. 1-Proposed Action	Alt. 2–No herbicides	Alt. 3-No Action
Grizzly Bear	Low	Moderate	Moderate
Gray Wolf	Low	High	Moderate
Bald Eagle	None	None	None
Sensitive Species	Low	Moderate	Moderate
MIS/Key Species	Low	High	Moderate

Table 4 – 22 summarizes the potential disturbance and displacement effects on wildlife under each of the alternatives.

TABLE 4 - 22. POTENTIAL DISTURBANCE / DISPLACEMENT EFFECTS ON WILDLIFE

	Alt. 1-Proposed Action	Alt. 2–No herbicides	Alt. 3-No Action
Grizzly Bear	Moderate	Low	Low
Gray Wolf	Low	Low	Low
Bald Eagle	Moderate	Low	Low
Sensitive Species	Moderate	Low	Low
MIS/Key Species	Moderate	Low	Low

Consistency with Forest Plan and other Laws, Regulations and Policies - Wildlife

The Custer Forest Plan (USFS, 1986) contains a Forest-wide standard stating that "the Forest has the responsibility to manage the land to maintain at least viable populations of existing native and desirable non-native vertebrate species, promote the conservation of federally listed threatened and endangered species and coordinate and cooperate with appropriate state, federal and private agencies in the management of habitats for major interest species." Additionally, the Forest Plan (USFS, 1986) identified a list of Management Indicator Species as directed by the National Forest Management Act. Alternative 1 would best meet the intent of these standards and objectives by doing the most to maintain native vegetation that is a critical habitat component for most wildlife. Alternatives 1 and 3 would be consistent with direction in the Forest Plan and other laws regarding weed control. Alternative 2 would be consistent with direction in the Forest Plan and other laws regarding weed control, but is not a very effective approach and has a more likelihood of altering habitats for wildlife in the long-term.

All alternatives would be consistent with the Migratory Bird Treaty Act, the Final Conservation Strategy for Grizzly Bears within the Greater Yellowstone Area (IGBC, 2003), the Lynx Conservation Assessment and Strategy (2000) and , the State's conservation plans for prairie dogs and sage grouse, and the Greater Yellowstone Bald Eagle Management Plan (Greater Yellowstone Bald Eagle Working Group, 1996). A Biological Assessment discussing effects of the Preferred Alternative will be prepared and submitted to the U.S. Fish & Wildlife Service to comply with the Endangered Species Act.

[43] Wolverine, peregrine falcon, northern goshawk, Baird's sparrow, blue-gray gnatcatcher, burrowing owl, greater sage grouse, loggerhead shrike, long-earred myotis, long-legged myotis, pallid bat, spotted bat, Townsend's big-eared bat, black-tailed prairie dog and white-tailed prairie dog.

[44] Goshawk, white-tailed deer, ruffed grouse, western kingbird, Bullock's oriole, yellow warbler, ovenbird, spotted towhee, Brewer's sparrow, sharp-tailed grouse, elk, golden eagle, merlin, mule deer, bighorn sheep, and pronghorn antelope.

WILDERNESS, RECOMMENDED WILDERNESS, AND INVENTORIED ROADLESS AREAS

WILDERNESS AND INVENTORIED ROADLESS AREAS - DIRECT AND INDIRECT EFFECTS, ALTERNATIVE 1 (PROPOSED ACTION)

Weeds in Wilderness would not be treated with aerial applications of herbicides in this alternative (or any alternative considered in this decision).

Aerial applications could be considered in roadless lands. The activity would be of short duration, less than one day.

Natural Integrity and Apparent Naturalness

Where weed treatment is effective, there will be short-term evidence including dead or wilting plants and areas of disturbed soils where plants have been pulled up or grubbed out. Where plants are dead or dying, and spraying was marked with dye, some people may recognize the weeds were sprayed, which may not appear natural.

This alternative would be the most aggressive and effective alternative in controlling weeds in Wilderness, recommended wilderness, and roadless areas, because of the multi-faceted treatment options (including herbicides), and the larger number of acres treated. This alternative would create the most improvements in natural integrity by restoring native vegetation to weed infested sites.

In the AB Wilderness, approximately 45 acres of herbicide treatment could occur initially. The effects on natural integrity would be an overall improvement of these areas as invading noxious weeds are excluded from wildlands and replaced with native plants (see the vegetation section). Apparent naturalness of treatment areas will improve as the evidence of noxious weeds decreases and is replaced with native vegetation. See the effects discussions under vegetation, wildlife and fish, and watershed for an estimate of the direct effects to these resources.

Herbicide treatment would decrease establishment and expansion of aggressive species in wildland areas, and reduce weed related impacts. The visual impact of spraying would be temporary and on most sites only last a few hours or less. Dying and wilting weed plants following herbicide treatment could be apparent. However, this appearance would be short-lived as surrounding vegetation would screen dead plants or blend in with native vegetation, as it grows dormant. Some desirable native vegetation could also be killed along with the weeds depending on the type of herbicide used.

Biological control with insects would only be used on large established weed patches, and would not be noticeable. Some people may notice areas where weeds were pulled, but it would likely not affect the apparent naturalness of the areas.

Remoteness and Solitude

Aerial spraying would not occur in Wilderness areas. Aerial spraying of herbicides within Inventoried Roadless areas would reduce feelings of remoteness and solitude during the one day within each area required to accomplish this work. Public traffic would be limited to these areas during spraying which would help mitigate any effect to the sense of remoteness or solitude. The public may encounter weed crews during hand spraying operations in Wilderness, recommended wilderness, or roadless areas, which may affect some people's sense of remoteness, and their opportunity for solitude. This effect would be very short term (typically only several days), and backcountry crews treating weeds would be small (typically 1-4 people).

The use of biological controls would not affect remoteness or solitude. Where weeds are pulled by hand, or chopped/grubbed recreationists may happen upon a work crew and have a reduced feeling of solitude. Treating large infestations with mechanical treatments would require larger crews and longer stays than

treating with herbicides, which may have a greater effect on the sense of remoteness and opportunities for solitude. Again, impacts would be short term, with crews being in one area typically no longer than a week.

Primitive Recreation Opportunities

With aerial herbicide application, treated areas would be closed to public use until it is safe for them to enter these areas, thus restricting the overall recreational opportunity during this time. Treatment would most likely occur during spring through fall. The public would be kept out of treatment areas for approximately 24-48 hours at a time, reducing opportunities for recreation during those periods.

Mechanical or biological treatments, because of their limited extent and minor impacts, will not impact opportunities for primitive recreation.

In all applications a “minimum tool analysis” would be used to determine the treatment option which would have the least impact on Wilderness values while effectively controlling the weeds which may include a combination of herbicides, biological, or mechanical treatments. See Appendix E for an example of a minimum tool decision tree.

WILDERNESS AND INVENTORIED ROADLESS AREAS - DIRECT AND INDIRECT EFFECTS, ALTERNATIVE 2 (NO HERBICIDE)

In this Alternative, no herbicide would be used, resulting in more acres being treated with biological controls. The effectiveness of both treatment types will be compromised because herbicides would not be used to suppress the established weeds.
The deliberate introduction and establishment of natural weed enemies (biological controls) are designed to reduce the plant’s competitive or reproductive capacities. Its purpose is generally not eradication, but rather a reduction in densities and rate of spread kept at an acceptable level. It has been argued that introduction of an exotic insect into a Wilderness setting is a human manipulation of a natural process.

Biological controls have a different magnitude of effect on the resource than do encroaching weeds. The weeds affect everything in a naturally functioning system from wildlife populations, to water runoff patterns. The exotic insects only directly affect the host weed species. This method is most effective on dense weed infestations over large areas, and would thus have limited effectiveness in the Absaroka Beartooth Area where target species are localized and in small patches.

Natural Integrity and Apparent Naturalness

This alternative has the potential to have the largest negative effect on naturally functioning ecosystems, and apparent naturalness in Wilderness and roadless lands. Weeds would only be treated with mechanical or biological controls in this alternative, both of which have limited applications for some species. Weeds would eventually occupy all suitable habitats, significantly changing the natural integrity of these lands and their apparent naturalness. See the vegetation section for a thorough discussion of uncontrolled weed population direct effects on the ecosystem, and the discussion under Alternative 2.

Remoteness and Opportunities for Solitude

Effects to remoteness and solitude under this alternative would be limited to backcountry recreationists encountering weed control crews who were primarily treating weeds with mechanical methods. The effect would be short term and isolated. Recreationists would not encounter any weed spraying crews, nor aerial applications in this alternative. Treating large infestations with mechanical treatments would require larger crews and longer stays than treating with herbicides, which may have a greater effect on the sense of remoteness and opportunities for solitude by increasing chances for encounters. Again, impacts would be short term, with crews in one area typically no longer than one week.

WILDERNESS AND INVENTORIED ROADLESS AREAS - DIRECT AND INDIRECT EFFECTS, ALTERNATIVE 3 (NO CHANGE FROM CURRENT MANAGEMENT)

Noxious weed control in Wilderness is currently only accomplished by hand grubbing and pulling. Hand control projects have focused on pulling only small patches of houndstongue and spotted knapweed. The Forest currently has no blanket authority to use herbicides for weed control in Wilderness. Typically, less than two acres are treated per year in Wilderness using hand control methods (pulling, grubbing and packing out weeds). Under this alternative approximately 45 acres of current infestations would likely not be treated because they were not covered under previous NEPA decisions for use of herbicides.

Focused information and education programs, hand control projects, strict controls on weed free feed requirements for recreational livestock have all had limited success in controlling the advancement of noxious weed infestations in Wilderness. Monitoring over the last several decades proves that weed populations are expanding despite these efforts at education and hand eradication.

Other Wilderness Area NEPA decisions have allowed chemical and biological control methods. Little or no weed control efforts using herbicides, hand control methods, and biological controls are occurring in the roadless portions of the Forest.

Natural Integrity and Apparent Naturalness

Expanding weed populations negatively affect the natural integrity of a landscape by displacing native vegetation. This species composition change has a ripple effect throughout the ecosystem. As a weed monoculture develops natural diversity of plant species is drastically reduced resulting in a direct effect to natural integrity. Weed invasions increase erosion, reduce water quality, and effect indigenous wildlife.

Under the No Action Alternative noxious weeds would spread at varying rates depending on the weed species, competing vegetation, disturbance history, and presence of vectors (water, recreationists, animals and vehicles). Under this alternative, it is likely that noxious weeds would eventually infest most suitable habitats within Wilderness, including sites that are presently weed-free. In roadless lands, spread would also go largely unchecked, though there is currently limited authority for herbicide control outside of Wilderness. Unchecked spread of noxious weeds would result in the unavoidable deterioration of the natural condition of the Wilderness and adjoining land diminishing the recreational experience and wildland values. Backcountry travelers who are knowledgeable about plant communities would be aware of the changing landscape, and would not meet their expectations for experiencing an intact ecosystem. The intent of the Wilderness Act is to maintain natural integrity and preserve naturally functioning ecosystems; that would not be realized with this alternative.

Remoteness and Solitude

Effects to remoteness and solitude under this alternative would be limited to backcountry recreationists encountering weed control crews who were primarily treating weeds with mechanical methods. In some cases recreationists may encounter crews applying herbicides using stock or trail vehicles outside of Wilderness, which could influence a user's sense of remoteness or solitude. These effects would be short term, limited to a few days in the summer. There would be no long term effects to remoteness or opportunities for solitude using either hand control methods, or limited chemical treatments outside of Wilderness.

WILDERNESS AND ROADLESS AREAS - CUMULATIVE EFFECTS

Several reasonably foreseeable past, present, and future activities could contribute to cumulative effects to natural integrity, apparent naturalness, opportunities for solitude and remoteness in Wilderness, recommended wilderness, and roadless areas. The analysis area for this discussion is the entire Custer National Forest. Effects are similar in all alternatives. Differences in cumulative effects between alternatives are more an issue of magnitude tied primarily to opportunities for solitude, than presence or absence of effect.

Increasing recreation pressure from all sorts of users including hikers, horseback riders, mountain bikers, and off-highway vehicle enthusiasts contribute to a decreased sense of solitude. These same users are potential vectors for spreading weeds in the Wilderness, recommended wilderness, and roadless areas and affecting natural integrity.

Management of fire also has potential cumulative effects on the natural integrity of these areas. Fire creates ready seedbeds for weeds to become established. Over 22% of the Custer National Forest has experienced recent wildfires, including areas within the AB Wilderness, recommended wilderness, and roadless areas. These areas are ripe for expanding weed infestations.

Irreversible and Irretrievable Commitment of Resources

Under Alternatives 2 and 3, once weeds become well established in Wilderness and Inventoried Roadless Areas, eradication would probably never occur, resulting in an irreversible loss of natural integrity and apparent naturalness.

Consistency with Forest Plan and other Laws, Regulations and Policies

All alternatives are consistent with management direction found in the Forest Plan, the Wilderness Act, and proposed Roadless Area Conservation Rule. All alternatives are consistent with FSM 21009.14 (13.4) for pesticide use in wilderness areas as long as the Regional Forester approves the annual pesticide use plan. Alternatives 1 and 3 would be consistent with direction in the Forest Plan and other laws regarding weed control. Alternative 2 would be consistent with direction in the Forest Plan and other laws regarding weed control, but is not a very effective approach and has a higher probability of increasing weed infestations within Wilderness, recommended wilderness, and roadless areas.

WILD AND SCENIC RIVERS

WILD AND SCENIC RIVERS - DIRECT AND INDIRECT EFFECTS, ALTERNATIVE 1 (PROPOSED ACTION)

There would be no substantial direct effects in Alternative 1 to the outstandingly remarkable attributes that make these rivers eligible for inclusion in the system.

Noxious weeds are present along all of these streams. Weeds are often spread with water as the vector. These established weed populations are difficult to treat effectively within close proximity to water. To date, only hand pulling treatments have been used. Under this Alternative, weeds within 50 feet of these rivers could be treated with herbicides that are approved for aquatic applications. .

Indirectly, the effective treatment of weeds along these corridors would improve scenery, and protect fish and wildlife values by restoring the native vegetation component.

WILD AND SCENIC RIVERS - DIRECT AND INDIRECT EFFECTS, ALTERNATIVE 2 (NO HERBICIDES) AND ALTERNATIVE 3 (NO CHANGE FROM CURRENT MANAGEMENT)

The effects for Alternatives 2 and 3 would be the same. Under the No Action Alternative 3, no aquatic approved herbicides are currently being used to treat weeds along the river corridor, as would be the case in Alternative 2 – no herbicides at all.

There would be no direct effects to the outstandingly remarkable features of these rivers in either alternative. See the fish and wildlife sections for detailed descriptions of direct effects. Indirectly, the lack of aggressive weed control may affect the natural appearance (scenery) of these corridors, as weeds occupy all suitable habitats. The presence of weeds could have a negative effect on the experience of some recreationists who expect a natural environment without the presence of exotic plant species.

Weeds can also increase sediment level, thus effecting fish populations. Also, weeds can decrease forage quality, thus displace wildlife in the river corridor.

WILD AND SCENIC RIVERS - CUMULATIVE EFFECTS

For all alternatives, there is likely to be some cumulative effects within the river corridors as recreation use increases. Increasing recreation use would likely increase the spread of weeds, which would affect the values of scenery, and potentially increase soil erosion which could affect the fishery and wildlife values.

Consistency with Forest Plan and other Laws, Regulations and Policies

All Alternatives are consistent with the goals and objectives of the Custer Forest Plan for eligible river segments to protect and maintain their potential classification. Alternatives 1 and 3 would be consistent with direction in the Forest Plan and other laws regarding weed control. Alternative 2 would be consistent with direction in the Forest Plan and other laws regarding weed control, but is not a very effective approach and has a higher probability of increasing weed infestations within wild and scenic river areas.

RESEARCH NATURAL AREAS

Research Natural Areas (RNA) are designated areas representing major, natural timber types or other plant communities in an unmodified condition. Weeds and the control of weeds may have a detrimental impact on RNAs. At present, there are no known weed infestations on designated or candidate RNAs. Weed establishment is highly unlikely in the Line Creek Plateau RNA due to its alpine setting. Lost Water Canyon and Poker Jim have suitable habitat that is vulnerable to weed invasion.

RNAS - DIRECT AND INDIRECT EFFECTS, ALTERNATIVES 1 (PROPOSED ACTION)

This alternative proposes to treat weeds that pose a threat to the plant communities within the RNA. Aerial application is excluded from the RNA (see Appendix C -Environmental Protection Measures). However, if any ground treatment with herbicide is planned within a RNA, concurrence must be obtained through the Research Station Director and Forest Supervisor.

The overall goal of RNA management is to maintain the full suite of ecological processes associated with the natural communities and conditions for which the RNA is designed to protect. Until recently, the primary course of action was to leave RNAs alone. However, with the emphasis on ecosystem management, more attention is being placed on restoration of natural processes such as fire, and control of invasive alien species, which alter the composition, and functioning of natural communities (Natural Heritage Program 2004). Weed treatments would protect the natural ecological composition of the RNA, and protect their identified values for research or special interest. Since weeds have been located adjacent to RNAs, effective treatment of those areas would help protect RNAs by helping to eliminate establishment of noxious and invasive weeds within them.

Proposed adaptive management activities include the identification and treatment of weeds that may enter RNAs through natural sources (e.g. wind, wildlife, fire). Following identified protection measures (Appendix C), effects from treatment of new locations would be the same as those already identified. If future additional treatment is needed within the RNAs, concurrence of the Research Station Director and the Forest Supervisor will ensure that herbicide use is consistent with FSM and Forest Plan direction.

RNAS - DIRECT AND INDIRECT EFFECTS, ALTERNATIVE 2 (NO HERBICIDES)

Biological control could be used when effective agents are available, however the weeds would always be present (biological control agents never eradicate their host). Effective biological control agents are only available for a few weed species. Mechanical pulling of small patches of non-rhizomatous weeds would be implemented where practical. The majority of the most aggressive weed species spread via their roots so pulling is not an effective method of control unless all of the roots are removed and the patch is very small. Also, extensive ground disturbance within the RNAs is not appropriate because of the damage to the

resource that is being protected. Under Alternative 2 most weeds would continue to encroach into these areas. This alternative would not provide opportunities to prevent the introduction of noxious weeds.

RNAS - DIRECT AND INDIRECT EFFECTS, ALTERNATIVE 3 (NO CHANGE FROM CURRENT MANAGEMENT)

Under this alternative, there would be limited effectiveness to treat weeds with a full array of tools and herbicides in RNAs. Weeds would continue to expand and diminish the unique plant values within and adjacent to these areas.

RNAS - CUMULATIVE EFFECTS

Under all alternatives, there are no past, present, or reasonably foreseeable actions that, along with the proposed activities within the RNAs, would cumulatively increase the risk of noxious weed spread, with the exception of wildfire. Cumulative effects may occur when weed-spreading activities occur next to RNAs. Under Alternative 1 effective treatments of weeds would maintain the ecological integrity and research value of the areas. Under Alternatives 2 and 3, the long-term lack of effective treatment of potentially new infestations, along with the likelihood that weeds would eventually spread from outside the RNAs into them, poses a risk to both the research value and biological diversity of RNAs.

Consistency with Laws and Policies – Research Natural Areas

All of the alternatives are consistent with the Forest Plan. All alternatives are consistent with direction in the Establishment Records by proposing specific control against target organisms, and by taking measures to control or eradicate these populations. Alternatives 1 and 3 would be consistent with direction in the Forest Plan and other laws regarding weed control. Alternative 2 would be consistent with direction in the Forest Plan and other laws regarding weed control, but is not a very effective approach and has a higher probability of increasing weed infestations within Research Natural Areas.

RECREATION

RECREATION - DIRECT AND INDIRECT EFFECTS - ALTERNATIVES 1 (PROPOSED ACTION)

Direct and indirect effects on recreation resulting from implementation would include short-term (one to seven days) encounters with herbicide treatment crews, short-term odors from some herbicides, and visual impacts from wilting plants. Additional effects resulting from these alternatives would be the protection of adjacent non-infested areas and preservation of intact plant communities, which would enhance the recreation experience. Concern over herbicides may cause some Forest users to choose to recreation in areas that have not been recently treated with herbicides. All weed treatment activities would be conducted in compliance with Travel Plan regulations, which allow for administrative use, unless otherwise prohibited by special order or other designation orders. When cross-country motorized travel is necessary to facilitate weed control, there will be short-term visual impacts in the form of tracks created by laying down grasses. In dry years, these tracks could remain visible throughout the season. While in wetter years the tracks could be erased, by rains and re-growth, before the fall.

All known weed infestations in dispersed sites, permitted use sites, special use sites, rental cabin sites, summer home sites and campgrounds could be treated in this alternative. Signs will be posted in recreational areas notifying the public of the herbicide used and stating the safe re-entry period as specified on the herbicide label (usually when the herbicide is dry on the plant surface).

Under this Alternative, herbicide treatments would decrease established and expansions of aggressive weed species into non-infested areas and reduce weed-related impacts on recreation. The visual impact of spraying would be temporary and on most sites only last a few hours. Dying and wilting plants following herbicide treatment would be apparent. However, this appearance would be short-lived as surrounding vegetation would screen dead plants or blend with native vegetation, as it grows dormant.

Long-term improvements include an overall reduction of stiff plant stalks and sharp or bristled seeds, and increase in the variety and amount of native flora. Treating invasive weeds would be an improvement in the overall quality of the recreational sites. Areas with aerial treatment are not near recreation sites or trails so this activity will not have an impact on recreational users.

RECREATION - DIRECT AND INDIRECT EFFECTS - ALTERNATIVE 2 (NO HERBICIDES) AND ALTERNATIVE 3 (NO CHANGE FROM CURRENT MANAGEMENT)

Under Alternative 2 No Herbicides would be used to treat the weeds so only small infestations would be pulled. Most of the weed patches would not be treated or control would be limited to biological control insects (which have minimal effectiveness). Consequently the long-term impact of limited weed control will be a substantial increase in weed density throughout most recreation sites, which will spread into adjacent areas.

Under Alternative 3 No Change from Current Management, most recreation sites are currently being treated with herbicides and this would continue. Under the Forest Service Manual (1950, 31b.5.a), the chief of the Forest Service has excluded the action of applying registered herbicides in campgrounds or recreation sites from NEPA requirement of a decision document and of a project file (Fed Register Vol. 57, 1992). To comply with the herbicide labels the sites treated in recreational areas will be signed to notify the public of a safe re-entry period (usual when the herbicide has dried on the plant).

RECREATION - CUMULATIVE EFFECTS

Cumulative effects from activities described at the beginning of this chapter would continue to impact recreation, affecting the location where and times when people can recreate at various locations across the Custer National Forest without being displaced by herbicide applications. Effects on recreation under any of the alternatives would be minor and short-term (one to seven days). While visitor displacement is the most likely direct effect of weed treatment, short-term (one to three years) visual impacts from cross-country motorized travel for the purpose of herbicide application are also possible. Also, an aggressive weed control program (as in Alternative 1) will maintain the native plants and current visual quality of native plant communities. While the less aggressive weed control alternatives (2 and 3) will continue to see an increase in weed species and a decrease in native plants resulting in a diminished visual quality for the landscape.

Consistency with Forest Plan and other laws and Policies – Recreation

Alternatives 1 and 3 would be consistent with direction in the Forest Plan and other laws regarding weed control. Alternative 2 would be consistent with direction in the Forest Plan and other laws regarding weed control, but is not a very effective approach and has a higher probability of increasing weed infestations within recreational areas. Effects from herbicide treatments will be of short duration, less than one day. Areas inside campgrounds and other developed recreation sites that are treated with herbicides will be posted to notify for public safety.

HERITAGE

HERITAGE - ALTERNATIVE 1 (PROPOSED ACTION)

Heritage resources are nonrenewable resources easily damaged by ground-disturbing activities. Although some artifacts are susceptible to damage from heavy equipment use, ground disturbance, or burning, it is the provenience of artifacts and features, or their horizontal and vertical location in relation to each other and to the soil deposits that is most important. Disturbance or movement of features and artifacts in relationship to each other disturbs or destroys the context of the information inherent in the site. Impacts from weed control activities could lessen the value of heritage resources by destroying important scientific data and diminishing the physical setting of sites. Heritage resources can be diminished by any change in their historical, architectural, archaeological, cultural character or ecological setting. Under the NHPA, an

impact is considered significant if it results in an adverse effect to a heritage resource that is on or eligible for the National Register of Historic Places. An adverse effect would occur if a management activity alters the characteristics of a historic property that qualifies for inclusion on the National Register of Historic Places (NRHP).

Archaeological Resources: Mechanical, manual, grazing and burning treatments have the highest potential for ground disturbance to archaeological sites. Mechanical digging, mowing or tilling pose the greatest threat. Mechanical and burning control measures could potentially disturb or destroy unidentified heritage resources on or near the ground surface. The potential for damage would vary with the amount of ground disturbance and burning under each alternative. Tilling weeds could damage artifacts and disrupt relative positions of cultural materials. Mixing organic matter in archeological sites could contaminate carbon 14 dating samples, making them unreliable for scientific analysis. Uncovering sites could increase the possibility of illegal artifact collecting.

Burning for weed control could destroy combustible cultural materials and damage stone and ceramic artifacts. The circumstance may occur, however, that burning could aid in the discovery and recovery of significant cultural resources, as seen at the cultural inventory following a wildfire in the Brewer, Kraft Springs, Stag Rock, Tobin, during 2000 and 2002.

Manually digging or pulling weeds could cause surface disturbance and displacement of buried archaeological materials. Sheep or goat grazing could cause trampling of artifacts and disturbance to features. Prescribed burning could affect sites with fire-sensitive materials. Herbicides and surfactants could impact the analytical potential of perishable materials such as wood and datable materials, although these effects have not been studied and the overall effect is not likely to be adverse.

In general, herbicides do not have the resident time that would affect chemical structure of surface archaeological remains. Biological methods would not be expected to damage sites, wooden beams or historic structures, since these herbivorous insects have a high degree of target host specificity.

Removal of weeds by any method could expose bare soil and increase soil erosion for a short time (typically a year or less), which could cause minor disturbance or damage to archaeological site features. While the adverse effects described for archaeological resources could potentially occur, there is a low risk of adverse impacts occurring. These effects would primarily be mitigated by avoidance of significant sites.

If it is predicted that adverse effects to archaeological resources cannot be avoided, the Forest would consult with the SHPO and other interested parties including tribes, concerning the steps to be taken to mitigate adverse effects. In addition, monitoring would be used to ensure that protection measures are followed and adequately protected heritage resources. If damage to an archaeological site is discovered during implementation, the activity would be immediately halted and SHPO notified about the resolution of adverse effects.

Ethnographic Resources: Effects on ethnographic resources, including traditional cultural properties, are difficult to estimate because traditional communities are sometimes unwilling to provide location data as well as information on the nature of impacts. However, some traditional gathering locations have been identified on the Custer National Forest. In some instances the mere presence of Forest Service workers or contractors in the area of a traditional cultural property can be an effect. Protection measures to alleviate auditory, visual, or other impacts on traditional cultural places require continuing consultation and coordination with traditional communities and flexibility in implementation.

Drift or chemical odor from herbicide applications or noise and dust from mechanical treatments may cause short-term adverse effects on traditional or religious sites. Protection measures that would minimize this impact include: using methods that reduce herbicide spray drift, posting signs during treatment activities, using direct hand application of herbicides onto target plants (avoiding surrounding plants), and consulting with tribes.

Tribes are concerned about exposure to or residue from herbicides during gathering, processing and consuming of gathered plant materials grown in or near lands where herbicides may have been applied.

Herbicides found in or on plants are called residues. Before a new herbicide can be sold for use in an agricultural setting, it has to be registered for agricultural use by the US Environmental Protection Agency (EPA). The registration process involves a careful consideration by EPA of possible health effects from the pesticide. The manufacturer of each new pesticide is required to submit scientific data to EPA that help evaluate the risk of health effects from its use. EPA reviews the submitted data and other available studies to determine if the pesticide is likely to affect human health or the environment. All the uses that have been approved by EPA are mentioned on the pesticide label.

There are a relatively small number of papers published on the subject of pesticide determination in medicinal plants and their final preparations (Zuin, et. al, 2000). Some reasons may be due to the complexity of the chemicals as well as the tedious and long analytical procedures. Most of the published papers are acquired with difficulty due to their limited access (periodicals of restricted circulation and/or in a wide variety of languages). In some of them, the scientific name of the medicinal plant investigated is not given.

Some studies have been done on herbicides used in commercially cultivated medicinal plant fields. One study tested more than 60 herbicides in a long-term study in order to develop chemical killing methods to control weeds in several medicinal plant fields (Zuin, et. al., 2000). The authors concluded that the utilization of those herbicides led to a considerable reduction in weed cover and a reduced manual work needed for weed control. The study also concluded that the use of chemicals did not result in any herbage yield reduction or morphological variation and did not influence the production of essential oils or the respective active principles.[45]

Although the plant materials in a treated area are dead, dying, chlorotic, brittle or deformed, (and hence are undesirable and very unlikely to be selected for ornamentals, medicine, or food) monitoring and consultation will occur where conflicts are known. If weed infestations threaten known special plant gathering areas (USDI, BLM and MT DNRC, 2002; USDA, Forest Service, 1996 and USDI, NPS, 1994), tribal consultation would be employed to adaptively add any new protection measures that might be needed to minimize effects to the plant population(s) in question and still meet project objectives (i.e., changes in weed treatment timing, application methods, treatment priority). Protection measures and adaptive management measures (Appendices C and E) would be employed.

Protection measures would be effective in avoiding impacts to fire sensitive areas of traditional concern when those areas are identified through additional consultation with traditional and tribal communities. Burning practices would be developed to reduce threats to traditionally used plant species or account for traditional practices in an area. Sometimes burning effects have been known to have a positive effect on plants by reducing competition from other plants and providing a temporary flush of nutrients. For all treatment activities, monitoring will ensure that site treatment recommendations are followed and adequate to protect heritage resources.

Invasive weeds can crowd out plants traditionally gathered for food, dress, or ceremonial purposes and can influence wildlife and fish habitat ecology. Treatment type or timing could interfere with traditional plant gathering by tribes utilizing areas of the Custer National Forest.

Curly cup gumweed (*Grindelia squarrosa*) and Broom Snakeweed (*Gutierresia sarothrae*), and Yellow Sweet Clover (*Melilotus officinalis*) are known to occur in isolated low elevation areas on or adjacent to the Forest, but are not typically priority plants for IPM treatment. All other documented species are a desired native component to the desired condition of overall plant community health and diversity.

Although the plant materials in a treated area are dead, dying, chlorotic, brittle or deformed, (and hence may be undesirable and very unlikely to be selected for ornamentals, medicine, or food) monitoring and consultation will occur where conflicts are known. If weed infestations threaten known special plant gathering areas (USDI, BLM and MT DNRC, 2002; USDA, Forest Service, 1996 and USDI, NPS, 1994), tribal consultation would be employed to adaptively add any new protection measures that might be needed to minimize effects to the plant population(s) in question and still meet project objectives (i.e.,

[45] Active principle is a constituent of a drug, usually an alkaloid or glycoside, on which the characteristic therapeutic action of the substance largely depends.

changes in weed treatment timing, application methods, treatment priority). Protection measures and adaptive management measures (Appendices C and E) would be employed.

Protection measures (Appendix C) would be expected to greatly limit the risk of adverse impact to plants that have cultural importance. Given the protection measures (Appendix C), effects to heritage resources associated with weed removal are estimated to be minor. While there may be short-term removal of important plants, measures require re-establishment of desired vegetation, which would compensate for the short-term reduction in the species.

HERITAGE - ALTERNATIVE 2 (NO HERBICIDE)

Weeds would continue to spread more rapidly as compared to the other two alternatives and over a shorter amount of time would likely reduce or endanger native plant species used traditionally.

Under this alternative, the greater reliance on mechanical, manual, grazing, and burning methods would slightly increase the exposure to risk where archaeological sites could be damaged by ground-disturbing treatments. There would be no potential impacts from spraying herbicides under this no herbicide alternative. It eliminates the potential health risks to those who collect and use traditional plants. Otherwise, effects to both archaeological and ethnographic resources would be the same as described for Alternative 1.

HERITAGE - ALTERNATIVE 3 (NO ACTION – CURRENT MANAGEMENT)

Effects to both archaeological and ethnographic resources would be the same as described for Alternative 1, but with fewer protection measures and weed spread vulnerability. This alternative would also place more vulnerability to weed spread in the AB Wilderness area, as well as other areas of difficult access. Treatment methods would be fewer relative to the types of species specific and more environmentally friendly herbicides available for use, but would not be authorized for use under this alternative. Because of the likelihood of more weed spread, plant gathering areas could be placed in greater jeopardy by weeds out-competing traditionally used plants.

SOCIAL AND ECONOMIC

SOCIAL AND ECONOMIC – DIRECT AND INDIRECT EFFECTS – ALTERNATIVES 1 AND 3 (PROPOSED ACTION & CURRENT MANAGEMENT)

Economic Aspects. The appropriated funded weed treatment program on the Custer National Forest in 2006 was $130,000, in which a total of 1200 acres were treated. The present program level is not keeping up to the current rate of spread. Therefore, the losses will continue to increase annually as well as continue to threaten adjacent lands, but not as significantly as they would under Alternative 2.

There is an estimated displacement of 430 AUMs (Animal Unit Month) by noxious weeds on the Custer National Forest. These losses are reflected in reductions of revenues to the Federal government as well as a more local loss to the agricultural and livestock industries. The cost to the industry would equal ~$60,000 annually[46]. This scenario assumes that the level of noxious weeds will remain constant.

Federal payments to counties through PILT (based on acreage) or Secure Rural Schools and Community Self-Determination Act (based on an average of previous years' payments) would not be impacted under Alternatives 1 and 3.

---

[46] The Forest rangelands usually offer an average five month season of use, and by assuming a loss of 430 AUMs, it can be determined that equates to 86 cow/calf pairs. With the assumption of a 500 pound calf at market time and given the 2004 price of $138 per 100 pounds (cwt), the cost to the industry would equal ~$60,000 annually.

Lifestyle Aspects. Diverse native viewsheds would be essentially maintained. Public land enjoyment through general recreational camping, fishing, hunting would continue. Fish and wildlife habitat needed for quality fishing and hunting would be maintained.

Partnerships and Collaboration in Weed Management. Alternatives 1 and 3 encourage partnerships.

SOCIAL AND ECONOMIC – DIRECT AND INDIRECT EFFECTS – ALTERNATIVE 2 (NO HERBICIDE)

Over time, the exponential spread of weeds that would occur under Alternative 2 (estimated at 8-12% increase annually) would drastically affect the economy of the primary agricultural component of this area (including county revenues), lifestyles, and partnerships.

Economic Aspects. The economic effects of weeds spreading are often difficult as the costs are often hidden and the effects tend to be cumulative.

The population in and adjacent to the Custer National Forest is predominantly rural. The business patterns of the zone of counties are agricultural oriented. The economic effects of spreading noxious weed infestations could have severe impacts on the livelihood of these counties' residents. Under current economic conditions of decreasing land values and decreasing livestock market values, rural areas such as these are being economically threatened. The impact of weed infestations on the private land is an additional hardship, let alone the decrease in the productivity of Federal lands. This decrease of goods and services from the natural environment causes a significant impact on the areas' economic well-being, and the economic stability of these areas becomes somewhat strained. This is evident throughout the country as people move from rural-agricultural setting to urban communities which offer greater economic stability.

Leafy spurge alone results in $129 million annual economic loss to the livestock industry in Montana, Wyoming, and the Dakotas (Partners Against Weeds, BLM). Weeds reduce forage for livestock, cost the industry millions of dollars; and, in some cases render public lands and family ranches useless for grazing. Often times, weed infestations will significantly lower land values in surrounding areas. Noxious weeds may not have a major effect on land values in many parts of Montana and South Dakota because buyers may be "paying for the view", but real estate licensees are seeing more potential buyers scrutinize weed infestation and management practices before closing. On production-oriented land, noxious weeds are usually considered in land appraisals. In one analysis, the presence of a noxious weed that reduces carrying capacity by 60% lowered the value of the land from the original $220 to $100 per acre.

Currently, all weeds cost farmers over $100 million each year in expenses and crop production losses in Montana alone. Degraded wildlife habitat also reduces wildlife-associated recreational expenditures in most states. Their secondary impact on the economy is unknown, but likely ranges between $200 and $300 million each year (Sheley, et. al., 2005).

Spotted knapweed and leafy spurge rank as one of the largest weed problems on rangeland in Montana and South Dakota. They reduce livestock and big game forage, damages wildlife habitat and can double the amount of soil erosion from sites where they invade rangeland.

Without the use of herbicide within the project area, the weed rate of spread is projected to increase 10% annually as well as continue to threaten adjacent lands. This equates to a potential loss in carrying capacity of an estimated 50 additional AUMs displaced annually. This, in addition to current estimated loss of 430 AUMs, would equate to $67,000 lost in year 1 with a projected 10 year loss to the livestock industry at $133,000. These losses are reflected in reductions of revenues to the Federal government as well as a more local loss to the agricultural and livestock industries.

In addition to the projected loss to the livestock industry, a loss in wildlife habitat and big game animals can also be expected. Deer and elk are not known to use knapweed to any significant extent. A heavily infested knapweed stand should generally be considered out of production as big game range and result in economic loss.

Noxious weeds have a substantial impact on the economy and may cause job losses. Economic losses caused by leafy spurge and spotted knapweed have been calculated for Montana and South Dakota. Nearly 4.5 million acres of South Dakota are infested with noxious weeds. Statewide losses from noxious weeds exceed $80 million annually (SDSU, Wrage, et.al.). The cost of leafy spurge to grazing lands and wildlands in the upper Great Plains including states of Montana, North and South Dakota, and Wyoming is estimated at $129.5 million and represents a potential loss of 1,433 jobs. Spotted knapweed in Montana alone costs an estimated $42 million, money that could support 518 full time jobs in the state. If spotted knapweed invaded 34 million vulnerable acres in Montana, loss to the livestock industry alone is estimated at $155 million (MWMP, 2001). Knapweed impact is not limited to grazing land. Forested areas and forest productivity can also be affected.

Leafy spurge is considered the most persistent noxious weed. It has a wide habitat suitability, prolific reproduction capabilities, and strong competitive ability and is difficult to control. Loss of hay and beef cattle production is estimated at $7 million in North Dakota due to both the reduced forage production from leafy spurge competition and to cattle avoiding leafy spurge infested areas (Lym and Messersmith 1985). Forage availability for wildlife is similarly limited.

Other listed weeds produce somewhat similar effects on rangeland as the two species listed above. The economic impacts of these weeds are a direct correlation between loss of carrying capacity, loss of habitat, and acres infested.

Federal payments to counties through PILT (based on acreage) or Secure Rural Schools and Community Self-Determination Act (based on an average of previous years' payments) would not be impacted under Alternative 2.

Lifestyle Aspects. Viewsheds would be altered from a diverse landscape to patches of monocultures of invasive weeds. Fish and wildlife habitat needed for quality hunting and fishing would become displaced with invasive weeds. Public land enjoyment through general recreational camping, fishing, hunting would be lessened as annoying sticky / thorny weeds invade areas or recreational areas invaded by monocultures of weedy vegetative lifeforms.

Partnerships and Collaboration in Weed Management. Alternative 2 does not encourage partnerships and would erode existing and future partnerships with municipalities, adjacent landowners, and others.

CHAPTER 5

CONSULTATION, REFERENCES AND ACRONYMS/GLOSSARY

CONSULTATION

PUBLIC PARTICIPATION SUMMARY

Public Participation specific to the Custer National Forest Weed Management EIS Project is summarized in this chapter. The summary describes the public involvement, identifies persons and organizations contacted during preparation of the EIS, and specifies time frames for accomplishing goals in accordance with 40 CFR 1506.6

Public involvement in the EIS process includes the necessary steps to identify and address public concerns and needs. The public involvement process assists the agencies in: (1) broadening the information base for decision making; (2) informing the public about the Proposed Action and the potential long-term impacts that could result from the project; and (3) ensuring that public needs are understood by the agencies.

Public participation in the EIS process is required by NEPA at three specific points: the scoping period, review of Draft EIS, and receipt of the Record of Decision.

IMPLEMENTATION

Scoping is a process used to help identify specific areas of concern related to the proposal during the early portion of the detailed environmental analysis. A scoping document was sent on November 19, 2001 to 360 individuals, government agencies, tribal interests, news media, businesses, and organizations that have shown interest in similar projects on the CNF. This document provided information on the purpose and need for the project, described the proposed action, and asked for comments. People were asked to comment in 30 days, which period ended on December 31, 2001. The scoping document and mailing list are included in the project file.

A legal advertisement inviting comments was placed in The Billings Gazette (Billings, MT) and the Rapid City Journal (Rapid City, SD) in November 2001, summarizing the information provided in the letter. News releases were sent to local newspapers, as well. These media efforts helped to publicize the proposal and comment period.

The Notice of Intent (NOI) was published in the Federal Register on August 18, 2003. The NOI asked for public comment on the proposal from August 18 through September 15, 2003. In addition, the agency provided tribal and public notice, requesting comments via personal visits, scoping document, news releases, and CNF quarterly Notice of the schedule for NEPA projects.

In response to these efforts, nine letters, personal comments, or phone calls were received. Review of the public's responses showed that all respondents were in agreement that noxious and invasive weeds are of urgent concern on the CNF and surrounding areas and that steps should be taken quickly to reduce or eliminate their presence on the CNF. Of these, all but one supported the use of herbicides as part of the proposal, although some had questions or comments concerning the effects of the herbicides. The remaining one commenter either questioned the need for using herbicides or was concerned about the environmental effects of using herbicides. All comments were considered by the ID team and responsible official, and are documented in the project file. This project is also described on the Custer web page, http://www. http://www.fs.fed.us/r1/custer/projects/index.shtml .

A Notice of Availability for the Draft EIS was published in the Federal Register for the comment period. Also, a news release was provided at the beginning of the 45-day comment period on the Draft EIS to local news media. The Draft EIS was distributed to interested parties identified in the updated EIS mailing list.

CRITERIA AND METHODS BY WHICH PUBLIC INPUT IS EVALUATED

Comments received from the public are reviewed and evaluated by the Forest Service to determine if information provided in the comments would require a formal response or contain new data that may identify deficiencies in the EIS. Steps were then initiated to correct such deficiencies and to incorporate the information into the analysis.

CONSULTATION WITH OTHERS

The following organizations and agencies were consulted during preparation of the EIS:

U.S. Fish and Wildlife Service
U.S. Environmental Protection Agency
Montana Department of Fish Wildlife and Parks
Montana Department of Environmental Quality
Area Tribal Councils

LIST OF PREPARERS AND REVIEWERS

Responsibility	Interdisciplinary Team	Function
Final EIS Document	Kim Reid	Team Leader & Writer / Editor
Human Environment	Kim Reid	Noxious Weed Coordinator
Vegetation	Kim Reid	Rangeland Management Specialist
Aquatics	Darin Watchke	Fisheries Biologist
Water Quality	Mark Nienow	Hydrologist
Wildlife	Tom Whitford	Wildlife Biologist
Soil Resources	John Lane	Soil Scientist
Heritage Resources	Halcyon LaPoint	Archeologist
Wilderness, Wild and Scenic Rivers, Recreation	Kimberly Schlenker , Kim Reid	Recreation and Wilderness
Economics	Kim Reid	Economics
Maps	Dee Dee Arzy / Mary Gonzales	GIS Specialists
Additional weed information	Terry Jones / Sean Monahan	Beartooth RD Weed Specialists
Additional weed information	Jim Goodwin	Ashland RD Weed Specialist
Additional information	Laurie Walters- Clark	Sioux RD Weed Specialist
Additional information	Pat Pierson	Minerals Program Management
NEPA	Mark Slack	NEPA Compliance and Editor

REFERENCES

Alpert, et. al., 1997. Alpert P, ; Bone E., Holzapfel C. Invasiveness, invasibility and the role of environmental stress in the spread of non-native plants. Perspectives in Plant Ecology, Evolution and Systematics, Volume 3, Number 1, 1 June 2000, pp. 52-66(15). http://www.ingentaconnect.com/content/urban/291/2000/00000003/00000001/art00004#avail

Allendorf and Leary 1988. Allendorf, F. W., and R. F. Leary. 1988. Conservation and distribution of genetic variation in a polytypic species, the cutthroat trout. Conservation Biology 2: 170-184.

Bakke, David, 2002. USFS Report by David Bakke, Pacific Southwest Regional Pesticide Use Specialist. Analysis of Issues Surrounding the Use of Spray Adjuvants With Herbicides. December, 2002.

Bangs, E. 2003. Gray wolf recovery weekly progress report, week of 7/18/03 to 7/24/03. U.S. Fish & Wildlife Service. Helena, MT. 4 pages.

BASF Corporation, 2006. Plateau Herbicide Technical Bulletin. For Weed Control and Grass Growth Suppression on Roadsides, Pastures, Rangelands, and Other Non-crop Areas. 8 pp. http://www.vmanswers.com/lib/PDF/2545261_plateau_techbltn.pdf

Beck, 1994. K. G. Beck. How do weeds affect us all? Reprinted with permission from: 1994 Leafy Spurge Symposium, Bozeman, MT. July 26-29, 1994. pp. 3-4. http://www.lib.ndsu.nodak.edu/research/subjects/ag/spurge_wl/spurge/pdffiles/SYMPOSIU/94/11beck94.pdf

Behnke 1992; May 1996; as reported in Young 2001. Benke, R. J. 1992. Native trout of western North America. American Fisheries Society Monograph 6. Page 79.

Benefield, C.B., DiTomaso, J.M., Kyser, G.B., Orloff, S.B., Churches, K.R., Marcum, D.B., and G.A. Nader. 1999. Success of mowing to control yellow starthistle depends on timing and plants branching form. California Agriculture 53(2): 17-21

BIRC, ___. Bio-Integral Resource Center (BIRC). Integrated Vegetation Management (IVM) Program. http://www.efn.org/~ipmpa/Noxcontents.html

Black 1970. Black, J. H. 1970. Some aspects of the distribution, natural history and zoogeography of the toad genus *Bufo* in Montana. Master of Science Thesis, University of Montana. Missoula, Montana. 70 pp.

Bovey, R. W., C. Richardson, E. Burnett, M. G. Merkle, and R. E. Meyer. 1978. Loss of spray and pelleted picloram in surface runoff water. J. Environ. Qual. 7(2):178-180.

Boyer and Grue 1995. Boyer, R. and C. E. Grue. 1995. The need for water quality criteria for frogs. Environmental Health Perspectives. 103: 352-357.

Bussan, A.J. and W.E. Dyer. 1999. Herbicides and Rangeland. p. 116-132 *In* R.L. Sheley and J.K Petroff, eds. Biology and Management of Noxious Rangeland Weeds. Oregon State University Press, Corvallis, OR.

Busse et. al., 2004. Matt D. Busse, Gary O. Fiddler, Alice W. Ratcliff, Ectomycorrhizal Formation in Herbicide-Treated Soils of Differing Clay and Organic Matter Content, Water, Air, & Soil Pollution, Volume 152, Issue 1 - 4, Feb 2004, Pages 23 – 34. http://www.springerlink.com/(khlt1145alctbgr4sjqt5p45)/app/home/contribution.asp?referrer=parent&backto=issue,3,25;journal,19,315;linkingpublicationresults,1:100344,1

Byorth 1990. Byorth, P. A. 1990. An evaluation of Yellowstone cutthroat trout production in three tributaries of the Yellowstone River, Montana. Master's thesis. Montana State University, Bozeman.

Carbon County, Montana. 2002. Carbon County Herbicide Guidelines; Rangeland and Right of Ways - Updated July, 2002. (http://mtwow.org/Carbon-County-herbicide-recommendations.htm)

Carey and Bryant 1995. Carey, C. and C. J. Bryant. 1995. Possible interrelations among environmental toxicants, amphibian development and decline of amphibian populations. Environmental Health Perspectives 103 (suppl. 4): 13-17.

Carlson, J.C. 2004. Harlequin ducks: rare, local, little-known, and declining North American breeders. Birding. April, 2004.

Casey, D. 2000. Partners in Flight Draft Bird Conservation Plan for Montana. American Bird Conservancy. Kalispell, MT. 288 pages.

Cherry, M. 1997. The Black-backed and Three-toed Woodpeckers: Life History, Habitat Use, and Monitoring Plan. Unpublished review with management recommendations for the Gallatin National Forest, P.O.Box 130, Bozeman, MT, 59771. 19 pages.

Popp, James, 1995. Perplexing Peroxisome Proliferators. *Environmental Health Perspectives* Volume 103, Number 3, March 1995 http://www.ehponline.org/docs/1995/103-3/focus-2.html

Clementson, Connie, 1999. Tall Larkspur Control with Ammonium Sulphate Fertilizer. Rangelands, April 1999.

Connelly, J.W., M.A. Schroeder, A.R. Sands, and C.E. Braun. 2000. Guidelines to manage sage grouse populations and their habitats. Wildlife Society bulletin 28(4) 967-985.

Cooke 1981. Cooke, A. K. 1981. Tadpoles as indicators of harmful levels of pollution in the field. Environmental Pollution (Series A) 25: 123-133.

Cornell University, 1999. Pesticide Residue Monitoring and Food Safety. Cornell University Program on Breast Cancer and Environmental Risk Factors in New York State (BCERF) March 1999. Fact Sheet #25. http://envirocancer.cornell.edu/factsheet/Pesticide/fs25.foodSafety.pdf

Cronin et al, 1976. E. H. Cronin, D. B. Nielson, and Ned Madson. Cattle Losses, Tall Larkspur, and Their Control. Journal of Range Management. 29(5), September 1976.

Cronin, E. H., 1976. Impact on Associated Vegetation of Controlling Tall Larkspur. Journal of Range Management 29(3), May 1976. 5 p.

Cunningham 1999. Cunningham, G. R. 1999. Fish survey of the White River on the U.S. Air Force Badlands Bombing Range, Shannon County, South Dakota. Ecocentrics Report prepared for the South Dakota Department of Game, Fish, and Parks, Pierre. 7 pp.

Davis et al, 1993. Davis, ES, PK Fay, TK Chicoine, and CA Lacey. 1993. Persistence of Spotted Knapweed (Centaurea maculosa) Seed in Soil. Weed Sci. 41:57-61. http://jrm.library.arizona.edu/data/1997/501/039-043_sheley.pdf

DiTomaso, J.M. 1999. Invasive weeds in rangelands: Species, impacts, and management. Weed Science: Vol. 48, No. 2, pp. 255–265. http://www.bioone.org/bioone/?request=get-document&issn=0043-1745&volume=048&issue=02&page=0255

DiTomaso, J.M. 2001. Yellow Starthistle Information. http://wric.ucdavis.edu/yst/manage/Management.pdf

Dole 1971. Dole, J. W. 1971. Dispersal of recently metamorphosed leopard frogs *Rana pipiens*. Copeia, 1971(2): 221-228.

Dugger, B.D. and K.M. Dugger. 2002. Long-billed curlew *in* The Birds of North America. No. 628 (A. Poole and F. Gill, Eds.). The Birds of North America, Inc., Philadelphia, PA.

Duncan, Celestine, Jim Story, and Roger Sheley. Montana Knapweeds: Identification, Biology, and Management. http://www.montana.edu/wwwpb/pubs/knapweed/circ311.html

Ellison, W.G. 1992. Blue-gray gnatcatcher *in* The Birds of North America, No. 23 (A. Poole and F. Gill, Eds.). The Birds of North America, Inc., Philadelphia, PA.

EPA, 9/1994. EPA Re-registration Decisión (RED), Hexazinone. http://www.epa.gov/oppsrrd1/REDs/0266.pdf

EPA, 9/1994. EPA Hexazinone, FACTs sheet of the Reregistration Eligibility Decision Document (RED). http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg

EPA, 9/8/2003. EPA Docket number EPA-HQ-OPP-2003-0349, Document #0003 at http://www.regulations.gov. Document #0003 redirects to Human Health Assessment for Diuron, The REVISED HED Chapter of the Reregistration Eligibility Decision Document (RED). PC Code: 035505. Case 0046. DP Barcode D291546; September 8, 2003. http://www.regulations.gov/fdmspublic/ContentViewer?objectId=09000064800b78eb&contentType=pdf&disposition=inline

EPA, 9/30/2003. EPA Docket number EPA-HQ-OPP-2003-0349, Document #0002 at http://www.regulations.gov. Document #0002 redirects to The REVISED HED Chapter of the Reregistration Eligibility Decision Document (RED) for Diuron. PC Code: 035505. Case 0046. DP Barcode D291546; September 8, 2003. http://cfpub.epa.gov/oppref/rereg/status.cfm?show=rereg and http://www.regulations.gov/fdmspublic/ContentViewer?objectId=09000064800b78eb&contentType=pdf&disposition=inline

EPA, 6/30/2005. EPA 2, 4-D; RED Facts; http://www.epa.gov/opsrrd1/REDs/factsheets/24d_fs.htm

EPA, 8/10/2005. EPA Aminopyralid; Pesticide Tolerance; http://www.epa.gov/fedrgstr/EPA-PEST/2005/August/Day-10/p15523.htm

EPA, 8/10/2005. Pesticide Fact Sheet, Aminopyralid, August 10, 2005. 56 pages. http://www.epa.gov/opprd001/factsheets/aminopyralid.pdf

EPA, 11/23/2005. EPA Pesticide Product Registration, Conditional Approval; Aminopyralid. Federal Register. http://www.epa.gov/opprd001/factsheets/aminopyralid.pdf

Felicetti, L.A., C.C. Schwartz, R.O. Rye, M.A. Haroldson, K.A. Gunther, D.L. Phillips and C.T. Robbins. 2003. Use of sulfer and nitrogen stable isotopes to determine the importance of whitebark pine nuts to Yellowstone grizzly bears. Can. J. Zool. 81: 763-770.

Felsot, A. 2001. Assessing the safety of herbicides for vegetation management in the Missoula Valley region – A question and answer guide to human health issues. Food and Environmental quality laboratory Washington State University. Richland. http://www.umt.edu/sentinel/herbicidetoxreport.pdf

Fenton, M.B. and G.P. Bell. 1979. Echolocation and feeding behaviour of four species of *Myotis* (Chiroptera). Can. J. Zool. 57:1271-1277.

Fritts, S., E. Bangs, J. Fontaine, M. Johnson, M. Phillips, E. Koch, and J. Gunson. 1997. Planning and implementing a reintroduction of wolves to Yellowstone National Park and Central Idaho. Restoration Ecology 5: 7-27.

Forrest, S.C., T.W. Clark, L. Richardson and T.M. Campbell III. 1985. Black-footed ferret Habitat: some management and reintroduction considerations. Wyoming Wildlife BLM Tech. Bull. No. 2, 49 pages.

Foresman, K.R. 2001. The wild mammals of Montana. American Society of Mammalogists. Special Publication No.12. Allen Press, Inc., Lawrence, KS. 280 pages.

Genter, D.L. and K.A. Jurist. 1995. Bats of Montana. Montana Natural Heritage Program, Helena, for *Assessing Mines for Bats* Workshop—June 14-15, 1995, Helena, Montana.

Glover- Kerkvliet, Janet, 1995. Environmental Assault on Immunity. *Environmental Health Perspectives*, 103(3), March 1995. http://www.anapsid.org/cnd/hormones/enviroimmunity.html

Goebel 1996; as reported in Maxell 2000. Goebel, A.M. 1996. Systematics and conservation of bufonids in North America and in the Bufo boreas species group. Ph.D. dissertation, University of Colorado. Boulder, CO. 274 pp.

Goodwin, Kim and Roger Sheley. 2003. Revegetation Guidelines for Western Montana: Considering Invasive Weeds. Prepared for Missoula County Weed District, Montana. http://ext.nrs.wsu.edu/watershedrangeext/washingtonrangelands/doc/RevegFinal.pdf

Gould 1998. Gould, W. R. 1998. Sturgeon Chub: Species of Special Concern Status Review. http://www.fisheries.org/AFSmontana/SSCpages, Montana Chapter of the American Fisheries Society.

Gould 1998; USFWL 2001

Greater Yellowstone Bald Eagle Working Group. 1996. Greater Yellowstone bald eagle management plan: 1995 update. WY Game and Fish Department, Lander WY 825280. 47 pp.

Green, M.T., P.E Lowther, S.L. Jones, S.K. Davis and B.C. Dale. 2002. Baird's sparrow *in*

The Birds of North America. No. 638 (A. Poole and F. Gill, Eds.). The Birds of North America, Inc., Philadelphia, PA.

Gresswell 1995; as reported in MTFWP 2005. Gresswell, R. E. 1995. Yellowstone cutthroat trout. Pages 36-54 in M. K. Young, technical editor. Conservation assessment for inland cutthroat trout. U.S. Forest Service General Technical Report RM-GTR-256.

Gresswell 1995; as reported in Young 2001

GYCC, 2000. Greater Yellowstone Coordinating Committee Informal Report. Invasive Species Management Assessment and Recommendations. 6 p.

GYCC 2001. Greater Yellowstone Coordinating Committee Informal Report. Status of Aerial Spraying for Noxious Weeds and Distribution of Key Noxious Weeds on Federal Land in the Greater Yellowstone Area. 3 p.

Hall and Henry 1992. Hall, R. J. and P. F. P. Henry. 1992. Assessing effects of pesticides on amphibians and reptiles: Status and needs. Herpetological Journal 2: 65-71.

Haug E.A., B.A. Millsap and M.S. Martell. 1993. Burrowing Owl *in* The Birds of North America. No. 61 (A. Poole and F. Gill, Eds.). The Birds of North America, Inc., Philadelphia, PA.

Hayward, G. G., D. T. Holland, R. Escano, N. Warren, C. Crocker-Bedford, T. Komberec, D. Sasse, L.Saunders-Ogg, B. Shuster. 1990. Goshawk habitat relationships *in* Old-growth habitat and associated wildlife species in the Northern Rocky Mountains. N. Warren, editor. USDA Forest Service, Northern Region, Missoula, Montana.

Henderson et al. 2000; as reported in Young 2001. Henderson, R., J. L. Kershner, and C. A. Toline. 2000. Timing and location of spawning by nonnative wild rainbow trout and native cutthroat trout in the South Fork Snake River, Idaho, with implications for hybridization. North American Journal of Fisheries Management 20: 584-596.

Hendricks and Reichel 1996. Hendricks, P., and J.D. Reichel. 1996. Preliminary amphibian and reptile survey of the Ashland District, Custer National Forest: 1995. Montana Natural Heritage Program. Helena, MT. 79 pp.

Hermanson, J.W. and T.J. O'Shea. 1983. *Antrozous Pallidus.* Mammalian Species 2113:1-8.

Hintz, Will, 2001. Canadian Weed Science Society - Biological Control Working Group Report 2001 – Biological Control (http://www.cwss-scm.ca/biological_control.htm)

Holton 1980; as reported in Gould 1998. Holton, G. D. 1980. The riddle of existence; fishes of special concern. Montana Outdoors 11: 2-6.

Holton, G. D. 2003. A field guide to Montana fishes. Montontna. Department of Fish, Wildlife and Parks. 95 pp.

Ibrahim et al. 1991. Weight of the evidence on the human carcinogenicity of 2,4-D. Environ Health Perspect. 1991 Dec;96:213-22.

Information Ventures, Inc. 1995a. Glyphosate: Pesticide Fact Sheet. Prepared for the U.S. Forest Service by Information Ventures, Inc. http://infoventures.com/e-hlth/pesticide/glyphos.html

________ 1995b. Triclopyr: Pesticide Fact Sheet. Prepared for the U.S. Forest Service by Information Ventures, Inc. http://infoventures.com/e-hlth/pesticide/triclopy.html

________ 1995c. Chlosulfuron: Pesticide Fact Sheet. Prepared for the U.S. Forest Service by Information Ventures, Inc. http://infoventures.com/e-hlth/pesticide/chlorsul.html

________ 1995d. Clopyralid methyl: Pesticide Fact Sheet. Prepared for the U.S. Forest Service by Information Ventures, Inc. http://infoventures.com/e-hlth/pesticide/clopyrali.html

________ 1995e. Dicamba: Pesticide Fact Sheet. Prepared for the U.S. Forest Service by Information Ventures, Inc. http://infoventures.com/e-hlth/pesticide/dicamba.html

________ 1995f. Hexazinone: Pesticide Fact Sheet. Prepared for the U.S. Forest Service by Information Ventures, Inc. http://infoventures.com/e-hlth/pesticide/hexazino.html

________ 1995g. Imazapyr: Pesticide Fact Sheet. Prepared for the U.S. Forest Service by Information Ventures, Inc. http://infoventures.com/e-hlth/pesticide/imazapyr.html

________ 1995h. Metsulfuron methyl: Pesticide Fact Sheet. Prepared for the U.S. Forest Service by Information Ventures, Inc. http://infoventures.com/e-hlth/pesticide/metsulf.html

________ 1995i. Picloram: Pesticide Fact Sheet. Prepared for the U.S. Forest Service by Information Ventures, Inc. http://infoventures.com/e-hlth/pesticide/picloram.html

________ 1995j. Sulfometuron methyl: Pesticide Fact Sheet. Prepared for the U.S. Forest Service by Information Ventures, Inc. http://infoventures.com/e-hlth/pesticide/sulfomet.html

________ 1995k. 2,4-D: Pesticide Fact Sheet. Prepared for the U.S. Forest Service by Information Ventures, Inc. http://infoventures.com/e-hlth/pesticide/24d.html

IGBC 1986. Interagency Grizzly Bear Committee. Interagency Grizzly Bear Guidelines. 99 pages.

IGBC 2003. Interagency Grizzly Bear Committee. Final Conservation Strategy for the Grizzly Bear in the Yellowstone Ecosystem. USDI Fish and Wildlife Service. Missoula, MT. 86 pages.

IPMPA, 2000. Integrated Pest Management Practitioners Association IVM Technical Bulletin. Spotted, Diffuse & Russian Knapweed. http://www.efn.org/~ipmpa/Noxknapw.html

Keeley, 2004. Jon E. Keeley. Ecological impacts of wheat seeding after a Sierra Nevada wildfire. International Journal of Wildland Fire, 2004, 13, 73–78

Kelly et al, 2002. Center for Invasive Plant Management. Online Invasive Plant Textbook (http://www.weedcenter.org)

Kennedy, et. al., 999. Theodore A. Kennedy, Shahid Naeem, Katherine M. Howe, Johannes M. H. Knops, David Tilman and Peter Reich Biodiversity as a barrier to ecological invasion. *Nature* **417**, 636-638 (6 June 2002). http://www.nature.com/nature/journal/v417/n6889/full/nature00776.html

Klassen 1998; as reported in Maxell 2000. Klassen, M.A. 1998. Observations on the breeding and development of the plains spadefoot, *Spea bombifrons*, in southern Alberta. Canadian Field Naturalist 112: 387-392.

Klute, D.S., L.W. Ayers, M.T. Green, W.H. Howe, S.L. Jones, J.A. Shaffer, S.R. Sheffield, and T.S. Zimmerman. 2003. Status Assessment and Conservation Plan for the Western Burrowing Owl in the United States. USDI, Fish and Wildlife Service, Biol. Tech. Pub. FWS/BTP-R6001-2003, Washington, D.C. 108 pages.

Laugenberg et al., 2005. Stephen M. Laufenberg, Roger L. Sheley, James S. Jacobs, and John Borkowski. Herbicide Effects on Density and Biomass of Russian Knapweed (Acroptilon repens) and Associated Plant Species. Weed Technology: Vol. 19, No. 1, pp. 62–72. http://www.bioone.org/pdfserv/i0890-037X-019-01-0062.pdf

Laycock, 1991. W.A. LAYCOCK. Stable states and thresholds of range condition on North American rangelands: A viewpoint. Journal of Range Management 44(5), September 1991. http://jrm.library.arizona.edu/data/1991/445/3layc.pdf

Lenard, S., J. Carlson, J. Ellis, C. Jones, and C. Tilly. 2003. P.D. Skaar's Montana Bird Distribution, 6th Edition. Montana Audubon, Helena, Montana.

Liebman et. al., 2001. Weed management: a need for ecological approaches. Edited by Matt Liebman, Charles L. Mohler and Charles P. Staver. Cambridge University Press.

Lym, R. G. and C. G. MESSERSMITH. 1985. Leafy spurge control and improved forage production with herbicides. *Journal of Range Management. Sept. 1985. 38(5):386-391.*

Maxwell et al., 1992. James F. Maxwell, Robert Drinkwater, David Clark, and John W. Hall. Effect of grazing, spraying, and seeding on knapweed in British Columbia. J. Range Manage. 45:180-182, March 1992. *http://jrm.library.arizona.edu/data/1992/452/16maxw.pdf*

Maxell, B. 2000. Management of Montana's amphibians: a review of factors that may present a risk to population viability and accounts on the identification, distribution, taxonomy, habitat use, natural history, and status and conservation of individual species. Report to USFS Region 1, Order Number 43-0343-0-0224. University of Montana, Wildlife Biology Program. Missoula, Montana. 161 pp.

May, B. E. 1996. Yellowstone cutthroat trout. Pages 11-34 in D. Duff, editor. Conservation assessment for inland cutthroat trout: distribution, status and habitat management implications. U.S. Forest Service, Northern, Rocky Mountain, Intermountain, and Southwestern Regions.

May, B. E., W. Urie, and B. B. Shepard. 2003. Range-Wide Status of Yellowstone Cutthroat Trout (*Oncorhynchus clarki bouvieri*): 2001. USDA Forest Service, Bozeman, Montana and Montana Departments of Fish, Wildlife and Parks, Helena, Montana

Mech, L. D. 1970. The Wolf: The ecology and behavior of an endangered species. Natural History Press, Doubleday Publishing Company, New York. 384 pages.

Messersmith, Calvin G, Rodney G. Lym, and Donald S. Galitz. 1985. Biology of leafy spurge. Reprinted from: Leafy Spurge, Monograph series of the Weed Science Society of America. ed. Alan K. Watson, 1985. Chapter 5 (3):42-56. ill. Published by: Weed Science Society of America. http://www.wssa.net/

Metter 1961; as reported in Maxell 2000. Metter, D.E. 1961. Water levels as an environmental factor in breeding season of *Bufo boreas boreas*. Copeia 1961: 488.

Miller et al. 1973. Miller, J.F., R.H. Frederick, and R.J. Tracer, 1973. Precipitation Frequency Atlas of the Western United States, Volume 1- Montana. NOAA – National Weather Service, Silver Spring, Maryland. http://www.wrcc.dri.edu/pcpnfreq.html

Miller et. al., 1998. P. Miller, Colorado State University post-doctoral research fellow, and P. Westra, Cooperative Extension weed science specialist and professor; bioagricultural sciences and pest management. 12/96. Reviewed 9/98.

Miller, Darren A., and T. Bently Wigley, 2004. Wildlife Society Bulletin: Vol. 32, No. 4, pp. 1016–1019. http://www.bioone.org/bioone/?request=get-document&issn=0091-7648&volume=032&issue=04&page=1016#i0091-7648-032-04-1016-tatum1

Missoula City-County Health Board (MCCHB). 2001. Report to Missoula City Council on the health Effects and Environmental Fate of Herbicides as they Pertain to Weed Management. www.ci.missoula.mt.us/packets/council/2001-11-19/referrals/herbicide%20Report.htm

Montana Bald Eagle Working Group. 1994. Montana Bald Eagle Management Plan. Bureau of Reclamation. Billings, MT. 104 pages.

Montana Dept. of Agriculture, 2000. Montana Noxious Weed List. http://agr.state.mt.us/programs/asd/noxweeds.shtml

Montana Dept. of Agriculture, 2002 County Declares War – War on Weeds Rages Throughout Carbon County. Montana Noxious Weed List. Carbon County News Insert. 12 p.

MDEQ 2004. Montana Department of Environmental Quality. Montana Water Quality Human Health Standards for Herbicides (http://www.deq.state.mt.us/wqinfo/Circulars/WQB-7.PDF, January 2004).

MDEQ, Montana Water Quality Standards, ARM Title 17. Montana Department of Environmental Quality. Helena, Montana http://www.fs.fed.us/r1/b-d/index.htm

MDEQ, 2002, Circular WQB-7, Montana Numeric Water Quality Standards. Montana Department of Environmental Quality. Helena, Montana. Helena, Montana http://www.deq.state.mt.us/wqinfo/Circulars/WQB-7.PDF

MTFWP 2000. MTFWP (Montana Department of Fish, Wildlife, and Parks). 2000. Cooperative Conservation Agreement for Yellowstone Cutthroat Trout within Montana. Montana Departments of Fish, Wildlife and Parks, Helena, Montana.

MTFWP 2005. MTFWP (Montana Department of Fish, Wildlife, and Parks). 2005. Filed guide to animals. Available: http://fwp.state.mt.us/fieldguide

MTNHP 2005. Montana Natural Heritage Program on the internet at http://nris.state.mt.us/animal/index.html.

MTNHP 2005. Montana Natural Heritage Program A web based information database. http://nhp.nris.state.mt.us/animalguide, Montana Natural Heritage Program, Helena, MT.

MTSGWG 2005. Montana Sage Grouse Working Group . Management Plan and Conservation Strategies for Sage Grouse in Montana. Prepared by the Montana Sage Grouse Working Group. 216 pages.

MTNHP 2005. Montana Natural Heritage Database on the internet at http://nris.state.mt.us/animal/index.html.

MT Prairie Dog Working Group. 2002. Conservation Plan for Black-tailed and White-tailed Prairie Dogs in Montana. Prepared by the Montana Prairie dog Working Group. 51 pages.

Montana State University Extension Service. 1990. RAVE (Relative Aquifer Vulnerability Evaluation): an on farm scoring system to evaluate aquifer vulnerability to pesticide contamination. 2nd Ed. MDA Tech. Bulletin 90-01A. MT Dept. of Agric. Agricultural Sciences Division, Helena, MT.

Montana State University Extension Service. 1995. Cold Weather Storage and Handling of Liquid Pesticides. MontGuide 8706. Greg Johnson, and Robert Hendrickson. 4 pp.

Montana State University Extension Service. 2000. Calculations and Conversions for Pesticide Applications. MontGuide MT 2000-14. Reeves Petroff, Pesticide Education Specialist. 4 pp.

Montana State University Extension Service. 2001. Maintenance, Cleaning and Storage of Ground Sprayers. MontGuide MT 8917. by Reeves Petroff, MSU Extension Pesticide Education Specialist, and Dr. Greg Johnson, MSU Entomology Department Head. 9 pp.

Montana State University Extension Service. 2005. Gerring the Most from Soil-Applied Herbicides. Fabian Menalled and William E. Dyer. http://scarab.msu.montana.edu/CropWeedSearch/Docs/GettingtheMostfromSoil-AppliedHerbicides.htm

Montana, Utah, Wyoming Cooperative Extension Services, 2002. Weed Management Handbook, 2001-2002. 281 pp.

Montana Weed Control Association (MWCA), 2001. The Montana Weed Management Plan. Montana Weed Coordinating Committee in cooperation with Federal and State Agencies, County Weed Districts, and Private Land Managers. 57 p.

Montana Weed Management Plan (MWMP). January 2001. Prepared by Celestine Lacey Duncan, Weed Management Services.

NDSU, 1995. North Dakota State University Extension Service,1995. W-866. Lym and Zollinger. Integrated Management of Leafy Spurge. http://www.ext.nodak.edu/extpubs/plantsci/weeds/w866w.htm

North Dakota State University, 1999. North Dakota Weed Control Guide by R. K. Zollinger, NDSU Extension Weed Specialist: http://www.ext.nodak.edu/extpubs/plantsci/weeds/w253/w253g01.htm

North Dakota State University, 2005. North Dakota Weed Control Guide by R. K. Zollinger, NDSU Extension Weed Specialist. W-s53-2a: http://www.ag.ndsu.nodak.edu/weeds/w253/w253-2a.htm#Troublesome

North Dakota State University, 2005. North Dakota Weed Control Guide by R. K. Zollinger, NDSU Extension Weed Specialist: W-253-5c http://www.ag.ndsu.nodak.edu/weeds/w253/w253-5c.htm

Nussbaum et al. 1983. Nussbaum, R. A., E. D. Brodie, and R. M. Storm. 1983. Amphibians and reptiles of the Pacific Northwest. University Press of Idaho, Moscow, Idaho. 332 pp.

O'Conner, T and M. Hillis. 2001. Conservation of post-fire habitat, black-backed woodpeckers and other woodpecker species on the Lolo National Forest. Unpublished review with management recommendations for the Lolo National Forest, Building 24, Fort Missoula, Missoula, MT, 59801. 17 pages.

OSU. 1994 Oregon State University Extension. OSU Extension Pesticide Properties Database. By P.A. Vogue, E.A. Kerle, and J.J. Jenkins. http://eesc.orst.edu/agcomwebfile/edmat/html/EM/EM8561/EM8561.html

OSU. 1999 Oregon State University Extension. Understanding pesticide persistence and mobility for groundwater and surface water protection. By E.A. Kerle, J.J. Jenkins and P.A. Vogue. http://eesc.orst.edu/agcomwebfile/edmat/html/EM/EM8561/EM8561.html

OSU. 1996a Oregon State University. EXTOXNET Extesion Toxicology Network, Pesticide Information Profiles. Triclopyr. http:://ace.orst.edu/info/exteeoxnet/pips/triclopy.htm

________ 1996b Oregon State University. EXTOXNET Extesion Toxicology Network, Pesticide Information Profiles. 2,4-D. http:://ace.orst.edu/info/exteeoxnet/pips/2,4-D.htm

________ 1996c Oregon State University. EXTOXNET Extesion Toxicology Network, Pesticide Information Profiles. Dicamba. http:://ace.orst.edu/info/exteeoxnet/pips/dicamba.htm

________ 1996d Oregon State University. EXTOXNET Extesion Toxicology Network, Pesticide Information Profiles. Picloram. http:://ace.orst.edu/info/exteeoxnet/pips/picloram.htm

________ 1996e Oregon State University. EXTOXNET Extesion Toxicology Network, Pesticide Information Profiles. Imazethapyr. http:://ace.orst.edu/info/exteeoxnet/pips/imazetha.htm

________ 1996f Oregon State University. EXTOXNET Extesion Toxicology Network, Pesticide Information Profiles. Glyphosate. http:://ace.orst.edu/info/exteeoxnet/pips/glyphosa.htm

________ 1996g Oregon State University. EXTOXNET Extesion Toxicology Network, Pesticide Information Profiles. Hexazinone. http:://ace.orst.edu/info/exteeoxnet/pips/hexazin.htm

________ 1996h Oregon State University. EXTOXNET Extesion Toxicology Network, Pesticide Information Profiles. Sulfometuron-methyl. http:://ace.orst.edu/info/exteeoxnet/pips/sulfomet.htm

Owen and Zelaya, 2005. Pest Management Science, Volume 61, Issue 3 , Pages 301 – 311.

Parks et al., 2004. Catherine G. Parks, Michael J. Wisdom, and John G. Kie. The Influence of Ungulates on Non-native Plant Invasions in Forests and Rangelands: A Review. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, La Grande, OR. http://www.fs.fed.us/r6/invasiveplant-eis/DEIS/Appendicies-DEIS-pdf/App-D-PNW-Causal-Paper-ungulates-0810.pdf

Platts, W. S. 1991. Livestock grazing. Pages 389-423 *in* Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats, W. Meehan, editor. American Fisheries Society Special Publication 19:389-423.

Power and Adams, 1997. SPECIAL SECTION: Perspectives of the Scientific Community on the Status of Ecological Risk Assessment. Environmental Management, 1997 Issue: Volume 21, Number 6.November 1997. P 803 – 830.

Prather et al., 2000, History, Mechanisms, and Strategies for Prevention and Management of Herbicide Resistant Weeds, 2000 Proceedings of the California Weed Science Society (Volume 52) p. 155-163

Ralphs and Olsen, 1992. Michael H. Ralphs and John D. Olsen. *Prior grazing by sheep reduces waxy larkspur consumption by cattle: An observation.* Journal of Range Management 45136-l 39, March 1992.

Ralphs, Michael H., 1995. Long term change in vegetation following herbicide control of larkspur. Journal of Range Management, September 1995, Vol. 48: 459-464.

Ralphs et al., 2003. Ralphs, M.H., Gardner, D.R., Pfister, J.A. 2003. Toxicophenology And Grazing Risk Models Of Tall Larkspur. Poisonous Plants Symposium Proceedings. http://www.ars.usda.gov/research/publications/publications.htm?SEQ_NO_115=127397

Rauscher, Ryan L. 1999. Loggerhead shrikes in Montana. Montana Fish, Wildlife & Parks

Reel, S., L. Schassberger, and W. Ruediger. 1989. Caring for our natural community: Region 1 – Threatened, Endangered, and Sensitive Species Program. USDA Forest Service, Northern Region. Missoula, MT. 321 pages.

Reichel 1995; as reported in Hendricks and Reichel 1996. Reichel, J. D. 1995. Preliminary amphibian and reptile survey of the Sioux District of the Custer National Forest:1994. Montana Natural Heritage Program. Helena, MT. 75pp.

Rew, Lisa, PhD, Montana State University, personal communication 2003 as cited in Gallatin National Forest DEIS

Reynolds, R., R. Graham, M. Hildegard Reiser, R. Bassett, P. Kennedy, D. Boyce, Jr., G. Goodwin, R. Smith, and E. Fisher. 1992. Management recommendation for the northern goshawk in the southwestern United States. General technical Report RM-217. Fort Collins, CO. USDA Forest Service, Rocky Mountain Forest and Range Experiment Station. 90 pages.

Rice, P., J. Toney, D. Bedunah, and C. Carlson. 1997. Elk winter forage enhancement by herbicide control of spotted knapweed. Wildlife Society Bulletin 25: 627-633.

Rice, P. M. 1999 Testimony of Peter M. Rice, Senate Agriculture Committee Hearing on Noxious Weeds (http://agriculture.senate.gov/Hearings/Hearings_1999/ric9958.htm)

Rice, P.M. 2002. INVADERS Database System (http://invader.dbs.umt.edu). Division of Biological Sciences, University of Montana, Missoula, MT 59812-4824.

Robinson, E. and L. Fox. 1978. 2,4-D. herbicides in central Washington, APCA J., 28,1015. in Grover. F. 1991. Environmental Chemistry of Herbicides. Nature, transport, and fate of airborne residues.

Robbins, C.T., C.S. Schwartz and L.A. Felicetti. 2004. Nutritional ecology of ursids: a review of newer methods and management implications. Ursus 15(2): 161-171.

Ruediger, B., J. Claar, S. Gniadek, B. Holt, L. Lewis, S. Mighton, B. Naney, G. Patton, T. Rinaldi, J. Trick, A. Vandehey, F. Wahl, N. Warren, D. Wenger, and A. Williamson. 2000. Canada Lynx Conservation Assessment and Strategy. USDA Forest Service, USDI Fish and Wildlife Service, USDI Bureau of Land Management, and USDI National Park Service. Forest Service Publication #R1-00-53, Missoula, MT. 142 pp.

Sabba, et. al., 2003. Inheritance of Resistance to Clopyralid and Picloram in Yellow Starthistle (*Centaurea solstitialis* L.) Is Controlled by a Single Nuclear Recessive Gene. Journal of Heredity, Volume 94, Number 6, pp. 523-527

Schmidt, C.A. 2003. Conservation assessment for the long-legged myotis in the Black Hills National Forest South Dakota and Wyoming. 22 pages.

Schmidt, C.A. 2003. Conservation assessment for the Townsend's big-earred bat in the Black Hills National Forest South Dakota and Wyoming. 23 pages.

Schroeder, M.A., J.R. Young, and C.E. Braun. 1999. Sage Grouse *in* The Birds of North America. No. 425 (A. Poole and F. Gill, Eds.). The Birds of North America, Inc., Philadelphia, PA.

Schwartz, C.C., M.A. Haroldson, K. Gunther, and D. Moody. 2002. Distribution of grizzly bears in the Greater Yellowstone Ecosystem, 1990-2000. Ursus 13:203-212.

Seburn et al. 1997. Seburn, C. N. L., D. C. Seburn, and C. A. Paszkowski. 1997. Northern leopard frog (*Rana pipiens*) dispersal in relation to habitat. In: D.M. Greeen (ed.) amphibians in decline: Canadian studies of a global problem. Society for the Study of Amphibians and Reptiles, Herpetological Conservation 1: 64-72.

Segawa, et. al., 2003. Dissipation and Off-site Movement of Forestry Herbicides in Plants of Importance to California Tribes. Randy Segawa, Clarice Ando, Carissa Gana, and Kean S. Goh. 5 pp. http://www.siamesegroup.com/Application/HPLC/HPLCAPP1.pdf

Servheen. 1993. Grizzly bear recovery plan. USDI Fish and Wildlife Service. Missoula, MT. 181 pages.

Sheley, Roger L. and Janet K. Petroff, 1999. *Biology and Management of Noxious Rangeland weeds.* Oregon State University Press, Corvallis OR. 438 p.

Sheley, 2000. An Ecologically Based Decision Support System for Managing Leafy Spurge Infested Rangeland (http://www.team.ars.usda.gov/reports/00rep/00sheley.html)

Sheley, P. M., et al, 2001. Impacts of Noxious Weeds (http://www.weedawareness.org/impacts.html)

Sheley, Roger L., Bret E. Olson, Carla Hoopes, 2005. What is so dangerous about the impacts of noxious weeds on Montana's ecology and economy? http://www.aces.edu/pubs/docs/A/ANR-0846/

Smith, D. 1998. Yellowstone wolf project: annual report, 1997. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, WY. YCR-NR-98-2. 20 pages.

Smith, D. 1998. Yellowstone wolf project: annual report, 1997. National Park Service, Yellowstone Center for Resources, Yellowstone National Park, WY. YCR-NR-98-2. 20 pages.

South Dakota Administrative Rules - Surface Water Quality Standards: http://legis.state.sd.us/rules/rules/7451.htm

SDGFP 2003. South Dakota Game, Fish, and Parks. South Dakota Bat Management Plan (Draft). Prepared by the South Dakota Bat Working Group. 87 pages.

South Dakota State University. "Noxious Weeds in South Dakota—Extension Special Series 34," by Leon J. Wrage and Darrell L. Deneke, and published by the South Dakota State University College of Agriculture and Biological Sciences—United States Department of Agriculture.

Stangl, J.T. 2000. Ecology and Management of Bald Eagles on Hebgen and Earthquake Lakes, Gallatin County, MT. USDA Forest Service, Gallatin National Forest, Hebgen Lake Ranger District.

Stannard 1993. Mark Stannard. Overview of the Basic Biology, Distribution and Vegetative Suppression of Four Knapweed Species in Washington. Technical Notes Plant Materials #25. http://www.wsu.edu/pmc_nrcs/technotes/plant_materials/tntpm25.htm

Stebbins 1985. Stebbins, R.C. 1985. A field guide to western reptiles and amphibians. Houghton Mifflin Company, Boston. 336 pp.

Stebbins and Cohen 1995; as reported in Maxell 2000. Stebbins, R. C. and N. W. Cohen. 1995. A natural history of amphibians. Princeton University Press. Princeton, NJ. 316 pp.

Stoddart, L.A., A.D. Smith, and T.W. Box. 1975. *Range Management.* McGraw-Hill Inc. 532 pp.

Tatum, Vickie L., 2004. Toxicity, transport, and fate of forest herbicides. *Wildlife Society Bulletin:* Vol. 32, No. 4, pp. 1042–1048. http://www.bioone.org/bioone/?request=get-document&issn=0091-7648&volume=32&page=1042#i0091-7648-032-04-1042-wssa1

Teske, M. E., H. W. Thistle, and R. E. Mickle. 1999. Modeling Finer Droplet Aerial Spray Drift and Deposition. Vol. 16(4): 351-357 © 2000 American Society of Agricultural Engineers 0883-8542 / 00 / 1604-351. http://asae.frymulti.com/request.asp?JID=3&AID=5216&CID=aeaj2000&v=16&i=4&T=2

Thompson, H. M. 1996. Interactions between pesticides; a review of reported effects and their implications for wildlife risk assessment. Ecotoxicology 5:59-81.

Thurow and King 1994; as reported in Young 2001. Thurow, R. F., and J. G. King. 1994. Attributes of Yellowstone cutthroat trout redds in a tributary of the Snake River, Idaho. Transactions of the American Fisheries Society 123: 37-50.

Tigner, J. and E.D. Stukel. 2003. Bats of the Black Hills: a description of status and conservation needs. SDGFP, Wildlife Division Report 2003-05. South Dakota Department of Game, Fish and Parks, Pierre, SD, 94 pages.

Tomback, D., S. Arno, R. Keane. 2001. Whitebark pine communities: ecology and restoration. Island Press, Washington, D.C. 440 pages.

Trapp, J. 2005, MT Fish, Wildlife & Parks, personnel communication on 4/1/05).

Tu, M., C. Hurd, and J. M. Randall. 2001. Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas. The Nature Conservancy Wildland Invasive Species Team. http://tncweeds.ucdavis.edu/handboak.html

Tu, et. al. 2003. Weed Control Methods Handbook. The Nature Conservancy. Adjuvents. 25 pp.

Tyser et al., 1998. Robin W. Tyser, Jennifer M. Asebrook, Rachel W. Potter & Laurie L. Kurth Roadside Revegetation in Glacier National Park: Effects of Herbicide and Seeding Treatments. Restoration Ecology Volume 6 Issue 2 Page 197 - June 1998 doi:10.1111/j.1526-100X.1998.06211.x. http://www.blackwell-synergy.com/links/doi/10.1111/j.1526-100X.1998.06211.x/full/

USDA, Agricultural Research Service (ARS), 2001. Panter, et. al. Larkspur Poisoning: Toxicology and Alkaloid Structure Activity Relationships. (http://www.nal.usda.gov/ttic/tektran/data/000011/89/0000118967.html)

USDA, Agricultural Research Service (ARS), 2000. Pfister, et. al. Toxic Plants and Chemicals in Water and Environment. CRIS 5428-32630-008. (http://www.nal.usda.gov/fsrio/ppd/ars05o.htm)

USDA, Agricultural Research Service (ARS), 1998. Ralphs, et. al. Toxic Alkaloid Response to Herbicides used to Control Tall Larkspur. (http://www.nal.usda.gov/ttic/tektran/data/000007/98/0000079871.html)

USDA, Forest Service (FS), 1986. Custer National Forest Plan. Billings. Montana.

USDA, Forest Service (FS), 1987. Gallatin National Forest Plan. Bozeman. Montana.

USDA, Forest Service (FS), 1987. Custer National Forest Noxious Weed EIS. Billings, Montana.

USDA, Forest Service (FS), 1995. …Ethnographic Overview of the McKenzie, Medora, Sioux, Ashland, and Beartooth Ranger Districts of the Custer National Forest. Prepared by Sherrie Deaver and Ann Kooistra-Manning, Ethnoscience for the Custer National Forest Plan. Billings. Montana. (A Confidential Report – not in Project File).

USDA, Forest Service (FS), 1996. …Traditional Plant Study, A Confidential Report. Prepared by Price, et.al. for the Custer National Forest Plan. Billings. Montana. 27 pp. (A Confidential Report – not in Project File).

USDA, Forest Service (FS), 1996. Lolo National Forest. Mormon ridge big game winter range restoration, Environmental Impact Statement. Missoula MT.

USDA, Forest Service (FS), 2001. Guide to Noxious Weed Prevention Practices

USDA, Forest Service (FS), 2001. Lolo National Forest. FEIS Big Game Winter Ranger and Burned Area Weed Management. http://www.fs.fed.us/r1/lolo/projects/index-big-game-weeds.shtml

USDA, Forest Service (FS), 2001. Lolo National Forest. Big Game Winter Range and Burned Area Weed Management on the Lolo National Forest. Missoula, Montana.

USDA, Forest Service (FS), 2002. Beaverhead-Deerlodge National forest Noxious Weed Control. Final Environmental Impact Statement and Record of Decision. May 2002.

USDA, Forest Service (FS), 2002. Bitterroot National Forest Noxious Weed Control. Final Environmental Impact Statement and Record of Decision. March 2003.

USDA, Forest Service (FS), 2003. Custer National Forest Plan 2003 Monitoring Report.

USDA, Forest Service (FS), 2003. Helena National Forest Weed Treatment Project. Final Environmental Impact Statement.

USDA, Forest Service (FS), 2004. Fisheries and Herbicides Work Group Final Findings and Recommendations, March 8, 2004.

USDA, Forest Service (FS), 2005. Gallatin National Forest Weed FEIS (2005).

USDA, Forest Service (FS), 2005. Gallatin National Forest Noxious and Invasive Weed Treatment Project, FEIS

USDA, Forest Service (FS), 2005. Inyo National Forest Integrate Weed Mangement, EA. http://www.fs.fed.us/r5/inyo/projects/weed_ea.shtml

USDA, Forest Service (FS), 2005. Pacific Northwest Region. Preventing and Managing Invasive Plants Final EIS Appendix. Common Control Measures. Prepared by Linda Mazzu. 64 pp.

USDA, Forest Service (FS), 2006. Fire Effects Information System database. http://www.fs.fed.us/database/feis/

USDA, Forest Service (FS), 2006. Pesticide Management and Coordination web site: http://www.fs.fed.us/foresthealth/pesticide/index.shtml

USDA, Forest Service (FS), 1995. Vanquish risk assessment final draft. Syracuse Environmental Research Associates, Inc (SERA).

________ 1996. Vanquish (dicamba) risk assessment final report. Syracuse Environmental Research Associates, Inc. (SERA).

________ 1996. Selected commercial formulations of triclopyr – Garlon 3A and Garlon 4 risk assessment final report. Syracuse Environmental Research Associates, Inc. (SERA).

________ 1996. Selected commercial formulations of glyphosate – Accord, Rodeo, Roundup and roundup Pro risk assessment final report. Syracuse Environmental Research Associates, Inc. (SERA).

________ 1997. USDA Forest Service. Effects of surfactants on the toxicity of glyphosate, with specific reference to Rodeo. Syracuse Environmental Research Associates, Inc. (SERA).

________ 1997. USDA Forest Service. Selected commercial formulations of hexazinone – human health and ecological risk assessment final report. Syracuse Environmental Research Associates, Inc. (SERA)

________ 1997. USDA Forest Service. Use and assessment of marker dyes used with herbicides. Syracuse Environmental Research Associates, Inc. (SERA)

________ 1998. 2,4-Dichlorophenoxyacetic acid Formulations - Human Health and Ecological Risk Assessment. Final Report. SERA TR 95-21-09-01d. (SERA).

________ 1998. 2,4-Dichlorophenoxyacetic acid Formulations – Human Health and Ecological Risk Assessment Final Report. Syracuse Environmental Research Associates, Inc. (SERA).

________ 1998. Sulfometuron mthyl (Oust) final draft.. Syracuse Environmental Research Associates, Inc. (SERA)

________ 1999. Picloram (Tordon K and Tordon 22K) - Final Report. Syracuse Environmental Research Associates, Inc. (SERA)

________ 1999. Imazapyr (Arsenal, Chopper, and Stalker Formulations), Final Report. Syracuse Environmental Research Associates, Inc. (SERA)

________ 1999. Clopyralid (Transline), Final Report. Syracuse Environmental Research Associates, Inc. (SERA)

________ 2000. Metsulfuron methyl (Escort) Final Report. Syracuse Environmental Research Associates, Inc. (SERA)

________ 2001. Impazapic (Plateau and Plateau DG) – Human Health and Ecological Risk Assessment Final Report. Syracuse Environmental Research Associates, Inc. (SERA).

________ 2003. Glyphosate - Human Health and Ecological Risk Assessment. Final Report. Syracuse Environmental Research Associates, Inc. TR 02-43-09-04a. (SERA).

________ 2003. Picloram - Human Health and Ecological Risk Assessment. Final Report. Syracuse Environmental Research Associates, Inc. TR 03-43-16-01b. (SERA).

________ 2003. Triclopyr - Human Health and Ecological Risk Assessment. Final Report. Syracuse Environmental Research Associates, Inc. TR 02-43-13-03b. (SERA).

________ 2004. Clopyralid – Human health and Ecological Risk Assessment. Final Report. Syracuse Environmental Research Associates, Inc. TR 04-43-17-03c. (SERA).

________ 2004. Chlorsulfuron - Human Health and Ecological Risk Assessment. Final Report. Syracuse Environmental Research Associates, Inc. TR 04-43-18-01c. (SERA).

________ 2004. Dicamba - Human Health and Ecological Risk Assessment. Final Report. Syracuse Environmental Research Associates, Inc. TR 04-43-17-06d (SERA).

________ 2004. Imazapic - Human Health and Ecological Risk Assessment. Final Report. Syracuse Environmental Research Associates, Inc. TR 04-43-17-04b. (SERA).

________ 2004. Imazapyr - Human Health and Ecological Risk Assessment. Final Report. Syracuse Environmental Research Associates, Inc. TR 04-43-17-05b. (SERA).

________ 2004. Metsulfuron Methyl - Human Health and Ecological Risk Assessment. Final Report. Syracuse Environmental Research Associates, Inc. TR 04-43-17-01b. (SERA).

________ 2004. Sulfometuron Methyl - Human Health and Ecological Risk Assessment. Final Report. Syracuse Environmental Research Associates, Inc. TR 03-43-17-02c. (SERA).

USDA, Natural Resource Conservation Service (NRCS), 2004. Noxious Weed Treatment Quick Reference. 2004 Montana Noxious Weed Calendar Advisory Committee.

USDA, Poisonous Plant Research Laboratory, 2003. Larkspur (Delphinium spp.). (http://www.pprl.usu.edu/larkspur.htm)

USDA, Soil Conservation Service (SCS). 1971. Soil Survey of Powder River Area, Montana. USDA Soil Conservation Service and Forest Service, USDI Bureau of Land Management, and Montana Agricultural Experiment Station. U.S. Gov. Print. Office, Washington, DC.

USDA, Soil Conservation Service (SCS). 1975. Soil Survey of Carbon County Area, Montana. USDA Soil Conservation Service and Forest Service, and Montana Agricultural Experiment Station. U.S. Gov. Print. Office, Washington, DC.

USDA, Soil Conservation Service. 1988. Soil Survey of Harding County Area, South Dakota. USDA Soil Conservation Service and Forest Service, and South Dakota Agricultural Experiment Station. U.S. Gov. Print. Office, Washington, DC.

USDI, Bureau of Land Management (BLM). 1985. Final Environmental Impact Statement. Northwest Area Noxious Weed Control Program. Portland, OR. 295 pp.

USDI, Bureau of Land Management (BLM) – USDA Forest Service (FS), 2001. USDI BLM and USDA FS, Off-Highway Vehicle EIS for Montana, North Dakota, and portions of South Dakota. Appendix D. 250 pp.

USDI, Bureau of Land Management (BLM) and State of Montana DNRC, 2002. *The Northern Cheyenne Tribe and Its Reservation.* A Report to the BLM and State of Montana DNRC. Prepared by the Northern Cheyenne Tribe, April 2002. (A Confidential Report – not in Project File).

USDI, Bureau of Land Management (BLM). 2005. ENRS International Report for BLM. Chlorsulfuron Ecological Risk Assessment Final Report. Bureau of Land Management Contract No. NAD010156 ENSR Document Number 0909-020-650. 137 pp. http://www.blm.gov/nhp/spotlight/VegEIS/erap/assessments/Chlorsulfuron/Chlorsulfuron_Ecological_Risk_Assessment.pdf

USDI, Bureau of Land Management (BLM). November 2005. ENRS International Report for BLM. Diuron Ecological Risk Assessment Final Report. Bureau of Land Management Contract No. NAD010156. ENSR Document Number 09090-020-650. 135. pp. http://www.blm.gov/nhp/spotlight/VegEIS/erap/assessments/Diuron/Diuron_Ecological_Risk_Assessment.pdf and http://www.blm.gov/nhp/spotlight/VegEIS/hhra.htm

USDI, Bureau of Land Management (BLM). 2005. ENRS International Report for BLM. Sulfometuron Methyl Ecological Risk Assessment Final Report. Bureau of Land Management Contract No. NAD010156 ENSR Document Number 0909-020-650. 137 pp.ber 09090-020-650. 135 pp. http://www.blm.gov/nhp/spotlight/VegEIS/erap/assessments/Sulfometuron_Methyl/Sulfometuron_Methyl_Ecological_Risk_Assessment.pdf

USDI, Fish and Wildlife Service (USFWS), 1984. American peregrine falcon recovery plan (Rocky Mountain/Southwest population). Prepared in cooperation with the American Peregrine Falcon Recovery Team. USFWS, Denver, CO. 105 pages.

USDI, Fish and Wildlife Service (USFWS), 1993. Grizzly bear recovery plan. USDI Fish and Wildlife Service. Missoula, MT. 181 pages.

USDI, Fish and Wildlife Service (USFWS), 2000. Black-footed ferret fact sheet. October 2000. 2 pages.

USDI, Fish and Wildlife Service (USFWS), Nez Perce Tribe, National Park Service, and USDA Wildlife Services. 2002. Rocky Mountain Wolf Recovery 2002 Annual Report. T. Meier, ed. USFWS, Ecological Services, 100 N Park, Suite 320, Helena, MT. 47 pages.

USDI, Fish and Wildlife Service (USFWS), Nez Perce Tribe, National Park Service, and USDA Wildlife Services. 2003. Rocky Mountain Wolf Recovery 2003 Annual Report. T. Meier, ed. USFWS, Ecological Services, 100 N Park, Suite 320, Helena, MT. 51 pages.

USDI, Fish and Wildlife Service (USFWS), Nez Perce Tribe, National Park Service, and USDA Wildlife Services. 2004. Rocky Mountain Wolf Recovery 2004 Annual Report. T. Meier, ed. USFWS, Ecological Services, 100 N Park, Suite 320, Helena, MT. 77 pages.

USDI, Fish and Wildlife Service (USFWS), 2001. Updated Status Review of Sicklefin and Sturgeon Chub in the United States. U.S. Fish and Wildlife Service, Region 6, Denver, Colorado.

USDI, National Park Service (NPS), 1994. Every Morning of the World. Ethnographic Resources Study Bighorn Canyon National Recreation Area, including information on adjacent lands managemed by Custer National Forest and the Bureau of Land Management. Prepared by Peter Nabokov and Lawrence Loendorf. (A Confidential Report – not in Project File).

USDOE, Bonneville Power Administration. 2000. 2, 4-D: Herbicide Fact Sheet. Bonneville Power Administration: http://www.efw.bpa.gov/portal/Organizations/Government/Federal/Dept_of_Energy/BPA/Environment/NEPA/Vegetation/appenH.pdf

US EPA. 1989. US Environmental Protection Agency. Integrated Risk Information System. 2,4 – Dichlorophenozyacetid acid (2,4-D) (CASRN 94-75-7).

________1990. US Environmental Protection Agency. Integrated Risk Information System, Hexazinone available online at http://www.epa.gov/IRIS/subst/0246.htm.

________1990. US Environmental Protection Agency. Integrated Risk Information System, Chlorsulfuron available online at http://www.epa.gov/IRIS/subst/0027.htm.

________ 1991. Threatened, Endangered and Sensitive Species of the Intermountain Region. Fisheries and Wildlife Management – Intermountain Region, Ogden, Utah.

________ 1992. Risk assessment for herbicide use in Forest Service Regions 1,2,3,4 and 10 and on Bonneville Power Administration sites. USDA Forest Service Contract #53-3187-9-30.

________1995 US Environmental Protection Agency. Re-registration Eligibility Decision Picloram. August 1995

________ 1996. US Environmental Protection Agency. Health Effects Test Guidelines OPPTS 870.1100: Acute Oral Toxicity. EPA 712-C-96-1920, Washington, DC.

________ 1996. US Environmental Protection Agency. Health Effects Test Guidelines OPPTS 870.4100: Chronic Toxicity. EPA 712-C-96-210, Washington, DC.

________ 1996. US Environmental Protection Agency. Health Effects Test Guidelines OPPTS 870.1200: Acute Dermal Toxicity. EPA 712-C-96-190, Washington, DC.

________1997. US Environmental Protection Agency. Carcinogenicity Peer Review (4^{th}) of 2, 4-Dichlorophenoxyacetic acid (2, 4-D) Washington DC

University of Idaho Extension, 2005. Idaho's Noxious Weed Control Guide, 2005. http://info.ag.uidaho.edu/pdf/BUL/BUL0816-05.pdf

University of Minnesota Extension Service, 2006. 2006 Cultural and Chemical Weed Control in Field Crops. Pasture Grasses by Roger L. Becker. 9 pp.

Vannote et al. 1980. Vannote, R. L., G. W. Minshall, K.W. Cummins, J.R. Sedell, and C.E. Cushing. 1980. The river continuum concept. Canadian Journal of Fisheries and Aquatic Sciences. 37:130-137.

Varley and Gresswell 1988. Varley, J. D., and R. E. Gresswell. 1988. Ecology, status, and management of the Yellowstone cutthroat trout. American Fisheries Society Symposium 4:13-24.

Voos, G. and P. M. Groffman. 1997. Relationships between microbial biomass and dissipation of 2,4-D and dicamba in soil. Biol. Fertil. Soils 24:106-110.

Vyas. 1999. Factors influencing estimation of pesticide-related wildlife mortality. Toxicology and Industrial Health, Volume 15, Numbers 1-2, 1999, pp. 186-191(0).

Washington State University Cooperative Extension. 1995. Chemical Control for Woody Plants, Stumps and Trees. Stott W. Howard and Robert Parker. http://cru.cahe.wsu.edu/CEPublications/eb1551/eb1551.html

Watkins, L.C. 1977. *Euderma maculatum.* Mammalian Species. 77:1-4.

Watson, V.J., P.M. Rice and E.C. Monnig. 1989. "Environmental fate of picloram used for roadside weed control. Journal of Environmental Quality 18:198-205.

Werner et al. 2004. Werner, J. K., B. A. Maxell, P. Hendricks, and D. L. Flath. 2004. Amphibians and reptiles of Montana. Montana Press Publishing Company, Missoula, Montana. 262 pages.

Wiens and Titus 1991; as reported in Maxell 2000. Wiens, J.J., and T.A. Titus. 1991. A phylogenetic analysis of *Spea* (Anura: Pelobatidae). Herpetologica 47: 21-28.

Wilson, Richard, 11/6/2005. Cancer and Chemical Carcinogenisis. http://phys4.harvard.edu/%7Ewilson/cancer&chemicals/ccar.html

Woodsworth, G.C., G.P. Bell, and M.B. Fenton. 1981. Observations of the eclocation, fedding behaviour and habitat use of *Euderma maculatum* (Chiroptera: Vespertilionidae) in southcentral British Columbia. Canadian Journal of Zoology 59: 1099-1102.

Worthington, D.J. 1991. Abundance and distribution of bats in the Pryor Mountains of south central Montana and north eastern Wyoming. Montana Natural Heritage Program. Helena, MT. 23 pages.

Yates, W.E., N.B. Akesson, and D.E. Bayer. 1978. Drift of glyphosate sprays applied with aerial and ground equipment. Weed Sci. 26: 597–604

Youmans, H. 1992. Statewide elk management plan for Montana. MT Fish, Wildlife, & Parks, Helena, MT. 171 pages.

Young 2001. Young, M. K. 2001. Yellowstone Cutthroat Trout: Species of Special Concern Status Review. http://www.fisheries.org/AFSmontana/SSCpages, Montana Chapter of the American Fisheries Society.

Zeise, et. al., 1983. Lauren Zeise, Richard Wilson, and Edmund Crouch. Use of Acute Toxicity to Estimate Carcinogenic Risk. Risk Analysis, Vol. 4, No. 3, 1984

Zuin,Va^nia G. and Janete H. Y. Vilegas, 2000. Pesticide Residues in Medicinal Plants and Phytomedicines. Phytotherapy Research. *Phytother. Res.* 14, 73–88 (2000). http://www3.interscience.wiley.com/cgi-bin/fulltext/70001436/PDFSTART

Pesticide Related Web Links

The following are helpful pesticide related web links:

Agricultural Chemical Use Database [USDA, National Agricultural Statistics Service] - Provides interactive access to data from NASS on commodity acreages and active ingredient agricultural chemical use. Statistics are provided for selected states and crops only [Department of Agriculture (USDA)]

Areawide Pest Management Research Unit - Access descriptions of current research. [Department of Agriculture (USDA), Agriculture Research Service (ARS); Southern Plains Agricultural Research Center (SPARC)]
Center for Veterinary Biologics, USDA Animal and Plant Health Inspection Service - The Center regulates veterinary biologics [Department of Agriculture (USDA); Animal Plant Health Inspection Service]

Compliance and Enforcement - Information about environmental requirements. [Department of Agriculture (USDA)]

EPA Aquatic Acute Toxicity Bioassay Technique – Provides an EPA bioassay technique for testing acute toxicity in aquatic species sensitive to herbicides (including brook and rainbow trout). This technique is outlined in EPA toxicity testing manual entitled: *"Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms", EPA/600/4-90/027, September 1991.*

Household Products Database. - Health & Safety Information on Household Products. [Department of Health and Human Services (HHS), National Inst. of Health (NIH), National Library of Medicine (NLM); Specialized Information Services]

Leafy Spurge Herbicide Manual - Provides information concerning the use of herbicides and their integration with other weed control technologies for the control of leafy spurge. [Department of Agriculture (USDA), Agriculture Research Service (ARS)]

List of Approved Herbicide Formulations and Adjuvants - Lists approved herbicide formulations for the Bureau of Land Management for the current fiscal year. Updated periodically. [Department of the Interior; Bureau of Land Management]

Midcontinent Agricultural Chemical Research Program - Homepage for the research on occurrence, movement, flux, fate, and effects of agricultural chemicals, such as pesticides, in 25 states by the Midcontinent Agricultural Chemical Research Project (MACRP) with links to study results and publications. [Department of the Interior, U.S. Geological Survey (USGS)]

National Agriculture Compliance Assistance Center - Is the first stop for information about environmental requirements that affect the agricultural community [Environmental Protection Agency (EPA)]

National Pesticides Information Center (NPIC) - A service that provides objective, science-based information about a wide variety of pesticide-related subjects [Environmental Protection Agency (EPA)]

Office of Pest Management Policy [USDA] - Develops tools for assessing new soil-water-crop management schemes to make effective use of limited resources where salinity and/or pesticides are a concern. Includes the models, their descriptions and contacts [Department of Agriculture (USDA)]

Office of Pesticide Programs (OPP) - EPA activity of evaluating and reviewing pesticides and their use [Environmental Protection Agency (EPA)]

Pest Management Regional Centers [USDA Cooperative State Research, Education, and Extension] - Locate information on pest management by tactic, state or commodity in minimized pesticide use, enhanced environmental stewardship, and sustainable systems [Department of Agriculture (USDA); Cooperative State Research Education and Extension (CSREES)]

Pest Management [USDA, Natural Resources Conservation Service] - Policies, software, data, risk analysis, training modules and contacts for pest management [Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS)]

Pesticide Category of the Household Products Database - Browse the Pesticide Category of the Household Products Database [Department of Health and Human Services (HHS), National Inst. of Health (NIH), National Library of Medicine (NLM)]

Pesticide Data Program (PDP) - Data on pesticide residues in food [Department of Agriculture (USDA); Agricultural Marketing Service (AMS)]

Pesticide Management and Coordination - Provides information on Forest Service Policy regarding the use of pesticides on National Forest System lands and on the proper use of pesticides. [Department of Agriculture (USDA), Forest Service]

Pesticide Product Information System (PPIS) - Data concerning all pesticide products registered in the United States [Environmental Protection Agency (EPA); Office of Pesticide Programs (OPP)]

Pesticide Product Label System (PPLS) - A collection of images of pesticide labels which have been approved by EPA [Environmental Protection Agency (EPA)]

Pesticide Properties Database (USDA, ARS) - Database of pesticides with potential to move into ground and surface waters under a range of weather and soil conditions [Department of Agriculture (USDA), Agriculture Research Service (ARS); Alternate Crops & Systems Laboratory]

Pesticide Safety Education Program [USDA, Cooperative State Research, Education and Extension] - A directory of web sites and contacts for pesticide safety, pesticide applicator training and information on preventing exposure to pesticides [Department of Agriculture (USDA); Cooperative State Research Education and Extension (CSREES)]

Pesticides, Metals, Chemicals. Contaminants & Natural Toxins page - Explains the Food and Drug Administration's policies regarding these impurities in regulated products [Department of Health and Human Services (HHS), Food and Drug Administration (FDA); Center for Food Safety and Applied Nutrition.]

Pesticides, Recommended EPA Web pages - Links to EPA web site pages related to pesticide issues [Environmental Protection Agency (EPA)]

Plant Sciences Institute (PSI) - Discovers and develops biological, chemical, and physical processes and principles (including bioregulation) that will improve pest management systems, crop production efficiency, conservation of natural resources, environmental quality, and support of re [Department of Agriculture (USDA), Agriculture Research Service (ARS); Beltsville Agricultural Research Center (BARC)]

Production Input Industries - Key Topic (ERS) - Covers information on pesticides, fertilizers, machinery, energy, seed, and biotechnology products, all of which are agricultural production inputs. [Department of Agriculture (USDA); Economic Research Service]

Salinas Agricultural Research Station - USDA-ARS - Determine the basic biology of virus diseases of sugarbeets and vegetables in relationship to etiology, epidemiology, vector transmission and pathogenesis. [Department of Agriculture (USDA)]

Soil Physics, Pesticides, and Pathogens [USDA, ARS] - Develops tools for assessing new soil-water-crop management schemes to make effective use of limited resources where salinity and/or pesticides are a concern. Includes the models, their descriptions and contacts [Department of Agriculture (USDA), Agriculture Research Service (ARS)]

Soybean Rust Information Site - USDA's Web site supporting the goals of a coordinated response framework and providing stakeholders with timely and accurate information for managing soybean rust in 2005. [Department of Agriculture (USDA)]

USDA - Economic Research Service - Briefing Room, Agriculture Chemicals and Production Technology - Synthesizes ERS research on the economic and environmental factors involved in the adoption of management practices and technologies as farmers move to more environmentally friendly practices [Department of Agriculture (USDA)]

USDA Whitefly Knowledgebase - Contains numerous links to whitefly related sites, keys for identifying whiteflies, an extensive literature reference section, and other topics of related interests [Department of Agriculture (USDA)]

Worker Protection from Pesticides [USDA, Office of the Chief Economist.] - Links to worker protection standards, the WPS forum, and EXTension TOXicology NETwork's pesticide information written for the non-expert [Department of Agriculture (USDA); Office of the Chief Economist.]

http://www.science.gov/browse/w_105H.htm

ACRONYMS

CNF	Custer National Forest
DEIS	Draft environmental impact statement
EA	Environmental assessment
EIS	Environmental impact statement
EPA	Environmental Protection Agency
FQPA	Food Quality Protection Act of 1996
FEIS	Final environmental impact statement
FSH	Forest Service Handbook
FSM	Forest Service Manual
NEPA	National Environmental Policy Act
NFS	National Forest System
NOI	Notice of Intent
OHV	Off-highway vehicle
ROD	Record of Decision
USC	United States Code
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish Wildlife Service
USGA	United States Geologic Survey

ABBREVIATIONS AND SYMBOLS

a.e.	acid equivalents
a.i.	active ingredient
AEL	adverse-effect level
BCF	bioconcentration factor
cm	centimeter
DF	dry flowable
d.f.	degrees of freedom
EC25	concentration causing 25% inhibition of a process
EC50	concentration causing 50% inhibition of a process
g	gram, equivalent to about 0.03 ounce (28 g = 1 ounce)
HQ	hazard quotient
ka	absorption coefficient
ke	elimination coefficient
Kg	kilogram, equivalent to 2.2 pounds
Ko/c	organic carbon partition coefficient
Ko/w	octanol-water partition coefficient
Kp	skin permeability coefficient
L	liter
lb	pound
LC50	lethal concentration, 50% kill
LD50	lethal dose for 50% of population
LOAEL	lowest-observed-adverse-effect level
m	meter
mg	milligram
mg/kg/day	milligrams of agent per kilogram of body weight per day
Mg/kg	milligrams per kilogram
mg/L	milligrams per liter; equivalent to ppm
mM	millimole
MW	molecular weight
MOS	margin of safety
MSDS	material safety data sheet
NOAEL	no-observed-adverse-effect level
NOEL	no-observed-effect level
ppb	parts per billion
ppm	part(s) per million; equivalent to mg/L
RfD	reference dose
UF	uncertainty factor

GLOSSARY OF TERMS

Acid Equivalent (a.e.): The theoretical yield of the original parent acid from the active ingredient content of a formulation. Some acid-based pesticide molecules are sometimes altered to form either an ester or a salt. This helps a pesticide become more water soluble or impart other beneficial characteristics to a pesticide other than its pesticidal effects. So, some salt and ester formulations are expressed as both active ingredient (with the salt or ester component) and as acid equivalent (the yield of the original acid molecule). For example, the active ingredient for certain glyphosate formulations is 4 pounds per gallon while the acid equivalent for the same formulation is 3 pounds per gallon.

Active ingredient (a.i.): The effective part of a pesticide formulation that actually destroys the target pest or performs the desired functions, or the actual amount of a technical material present in the formulation.

Absorption: The process by which the agent is able to pass through the body membranes and enter the bloodstream. The main routes by which toxic agents are absorbed are the gastrointestinal tract, lungs, and skin.

Active ingredient: The main ingredient that produces the desired effect.

Acute exposure: A single exposure or multiple exposures occurring within a short time (24 hours or less).

Additive effect: A situation in which the combined effects of two herbicides is equal to the sum of the effect of each herbicide given alone. The effect most commonly observed when two herbicides are given together is an additive effect.

Adjuvant: Material added to the pesticide mixture to help the active ingredient do a better job of control. Examples of an adjuvant include: wetting agent, spreader, adhesive, emulsifying agent, and bark penetrant.

Adaptive Management: A concept of allowing decisions, which are focused on desired outcomes, to be made with the best information available and to adjust operations to achieve desired conditions. See Chapter 2 of this EIS for description of Adaptive Management as it applies to noxious and invasive weed management in the Custer National Forest.

Adsorption: The tendency of one herbicide to adhere to another material.

Affected Environment: The physical, biological, social, and economic environment where human activity is proposed.

Allelopathic Substances: Chemical compounds produced by plants (and microorganisms) that affect the interactions between different plants (and microorganisms).

Annual (plant): A plant species living for only one year or season.

Assay: A kind of test (noun); to test (verb).

Biennial: A plant that completes its life cycle within a two-year period. Germinates in the spring, overwinters, flowers the following spring or summer and dies back the following fall.

Bioaccumulation: The retention and concentration of a substance by an organism.

Bioconcentration: The net accumulation of a substance by an aquatic organism as a result of uptake directly from aqueous solution. Bioaccumulation = the net accumulation of a substance by an organism as a result of uptake directly from all environmental sources and from all routes of exposure (primarily from food or water that is ingested).

Biological Control (Biocontrol): The dispersal or release of biocontrol agents on a noxious weed infestation (see definition of infested acre), with the intent of establishing a population of a biological control agents. An agent can be an insect, fungus, bacterium, or any other life form that preys on the weed of concern. The release of agents can occur at a single location or scattered over a site. The release can be a few individuals, a container of many individuals, or several containers with thousands of individual agents. Releases at different locations, with the intent of establishing separate populations (at least 1/4 mile apart), constitute separate releases. Release of two species of biological control agents, at the same location, in the same year, is a single release.

Biodegradation: The series of processes by which living systems, particularly microorganisms, degrade chemical compounds, and the breakdown products may be either more or less toxic than the parent compound.

Biological diversity: The variety of life and its processes, including all life forms from one-celled organisms to complex organisms such as insects, plants, birds, reptiles, fish, other animals and the processes, pathways and cycles that link such organisms into natural communities.

Bio-magnification: When a compound may become progressively more concentrated in the body of certain animals as it moves up the food chain.

Carcinogen: A substance that causes or induces cancer.

Chronic exposure: Long-term exposure studies often used to determine the carcinogenic potential of herbicides. These studies are usually performed in rats, mice, or dogs and extend over the average lifetime of the species (for a rat, exposure is 2 years). These effects are considered to be permanent or irreversible.

Chronic toxicity: The capacity of a substance to cause adverse human health effects as a result of repeated exposure to a chemical for greater than half the life expectancy of the test subjects.

Contain Strategy: Weeds are geographically contained and are not increasing beyond the perimeter of the infestation. The objective is to control or eradicate along the perimeter of infestations to hold the infestation from spreading. Treatment within established infestations may be limited.

Contaminants: For herbicides, contaminants are impurities present in a commercial grade herbicide. For biological agents, contaminants are other agents that may be present in a commercial product.

Control Strategy: Seed production is prevented throughout the target patch and the area coverage of the weed is decreased over time. Prevent the weed species from dominating the vegetation of the area, but accept a low level of weed infestation.

Cumulative effects: Changes as a result of more than one action that may enhance or degrade a specific site.

Cumulative exposures: The summation of exposures of an organism to a chemical over a period of time.

Cytochrome P-450: Cytochrome P450 proteins in humans are drug metabolizing enzymes and enzymes that are used to make cholesterol, steroids and other important lipids.

Degradation: Physical or biological breakdown of a complex compound into simpler compounds.

Dermal exposure: Contact between a chemical and the skin.

Draft Environmental Impact Statement: The statement of environmental effects required for major Federal actions under Section 102 of the National Environmental Policy Act (NEPA), and released to the public and other agencies for comment and review.

Drift: That portion of a sprayed herbicide that is moved by wind off a target site.

Eradicate Strategy: The noxious weed species is eliminated including viable seeds and/or vegetative propagates.

Exotic plant: A non-native plant.

Forbs: A group of herbaceous (non-woody) plants, other than grasses, generally including wildflowers and many other plants, including those commonly referred to as weeds.

Forest Plans: The Land and Resource Management Plans for the Dakota Prairie Grasslands.

Formulation: The form in which a pesticide is packaged or prepared for use. A chemical mixture that includes a certain percentage of active ingredient (technical chemical) with an inert carrier.

Gross Area: An area of land occupied by one or more noxious weed species. The area is defined by drawing a line around the general perimeter of the infestation, not the canopy cover of the plants. The gross area may contain significant parcels of land that are not occupied by weeds.

Hazard analysis: Involves gathering and evaluating data on the types of injury or disease that may be produced by a substance and on the conditions of exposure under which injury or disease occurred.

Hazard Quotient: A Hazard Quotient (HQ) is the ratio between the estimated dose (the amount of herbicide received from a particular exposure scenario) and the Reference Dose (RfD).

Herbicide: A chemical that regulates the growth of or kills specific weeds or undesirable plants.

Hypersensitivity: A state of extreme sensitivity to an action of a chemical; a state of altered reactivity in which the body reacts with an exaggerated immune response to a foreign substance.

In vivo: Occurring in the living organism.

In vitro: Isolated from the living organism and artificially maintained, as in a test tube.

Inerts: Adjuvants or additives in commercial formulations that are not readily active with the other components of the mixture.

Inert ingredients: All ingredients in a formulated pesticide product that are not classified as active ingredients.

Infested Area (Occupied Area, Net Area): A contiguous area of land occupied by one or more weed species. The infested area is defined by drawing a line around the actual perimeter of area occupied by the canopy of the weed plants.

Inhalation: The movement of a chemical from the breathing zone, through lung tissues, and into the blood system.

Intake: Amount of material inhaled, absorbed through the skin, or ingested during a specified period of time.

Integrated Pest Management (IPM): The use of different techniques, in combination to control pests, with an emphasis on methods that are least injurious to the environment and most specific to the particular pest. For example, pest-resistant plant varieties, regular monitoring for pests, pesticides, natural predators of the pest, and good stand management practices may be used singly or in combination to control or prevent particular pests.

Invasive plant: A nonnative species that is likely to cause or has the potential to cause economic or environmental harm to the ecosystem under consideration or harm to human health.

Lethal Dose50 (LD50): A measure of acute toxicity. The dose of a herbicide calculated to cause death in 50% of a defined experimental animal population over a specified observation period. The observation period is typically 14 days.

Lowest-Observed-Adverse-Effect Level (LOAEL): The lowest dose of a herbicide in a study, or group of studies, that produces statistically or biologically significant increases in frequency or severity of adverse effects between the exposed population and its appropriate control.

Mutagenic: Adverse effects on genes that may result from exposure to a herbicide or biological agent.

Native vegetation: With respect to a particular ecosystem, a species that, other than as a result of an introduction, historically occurred or currently occurs in that ecosystem.

Natural community: An assemblage of organisms indigenous to an area that is characterized by distinct combinations of species occupying common ecological zones and interacting with one another.

No-observed-adverse-effect level: (NOAEL): An exposure level at which there are no statistically or biologically significant increases in the frequency or severity of adverse effects between the exposed population and its appropriate control; some effects may be produced at this level, but they are not considered as adverse, or as precursors to adverse effects. In an experiment with several NOAELs, the regulatory focus is primarily on the highest one, leading to the common usage of the term NOAEL as the highest exposure without adverse effects.

No-observed-effect concentration (NOEC): Synonymous with NOEL.

No Observed Effect Level (NOEL): In dose-response experiments, it is the exposure level which causes no statistically significant increase in frequency or severity of any effect between the exposed population and its appropriate controls.

Non-native vegetation: Any species that is not native to the ecosystem in question

Non-target: Any plant, animal, or organism that a method of application is not aimed at, but may accidentally be injured by the application.

No-Observed-Adverse-Effect Level (NOAEL): The dose of a herbicide at which no statistically or biologically significant increases in frequency or severity of adverse effects were observed between the exposed population and its appropriate control. Effects may be produced at this dose, but they are not considered to be adverse.

Noxious weeds: An invasive non-native plant specified by law as being especially undesirable, troublesome, and difficult to control.

Perennial: A plant species that has a lifespan of more than 2 years.

Persistence: Resistance to degradation due to low volatility and chemical stability. A persistent substance is expected to remain in the environment for a long time.

Pesticide: Any substance used to control, prevent, destroy, repel, or mitigate insects, rodents, fungi, weeds, or other forms of plant or animal life that are considered to be pests.

Photodegradation: The chemical transformation of a compound into smaller compounds caused by the absorption of ultraviolet, visible, or infrared radiation (light). In many cases photodegradation is an oxidation process. Many compounds, when exposed to sunlight, degrade to smaller compounds.

Plant community: An association of plants or various species found growing together in different areas with similar site characteristics.

Potency: The measure of the relative strength of a chemical.

Protection measures or practices: The identification of specific practices and methods that will reduce or eliminate adverse effects related to implementation of an alternative.

Reference dose: Oral dose (mg/kg/day) not likely to be associated with adverse effects over a lifetime of exposure, in the general population, including sensitive subgroups.

Registered herbicide: All pesticides sold or distributed in the United States must be registered by the U.S. Environmental Protection Agency, based on scientific studies, showing that they can be used without posing unreasonable risks to people or the environment.

Risk: In risk assessment, the probability that an adverse effect (injury, disease, or death) will occur under specific conditions of exposure to a risk agent.

Reproductive effects: Adverse effects on the reproductive system that may result from exposure to a herbicide or biological agent. The toxicity of the agents may be directed to the reproductive organs or the related endocrine system. The manifestations of these effects may be noted as alterations in sexual behavior, fertility, pregnancy outcomes, or modifications in other functions dependent on the integrity of this system.

RfD: Reference Dose, a numerical estimate of a daily exposure (mg/kg/day) to the human population, including sensitive subgroups such as children, that is not likely to cause harmful effects during a lifetime. RfDs are generally used for health effects that are thought to have a threshold or minimum dose for producing effects. The U.S. EPA derives these values.

Route of exposure: The way in which a herbicide or biological agent enters the body. Most typical routes include oral (eating or drinking), dermal (contact of the agent with the skin), and inhalation.

Selected herbicide: A chemical that is more toxic to some plant species than to others.

Surfactant: A specific type of additive to a pesticide formulation that is intended to reduce the surface tension of the carrier, to allow for greater efficacy of the pesticide.

Surrogate: A substitute; lab animals are substituted for humans or other wildlife in toxicity testing.

Synergistic effect: A situation is which the combined effects of two herbicides is much greater than the sum of the effect of each agent given alone.

Teratogenic: Causing structural defects that affect the development of an organism; causing birth defects.

Treated Area: An infested area (see definition of infested area) where weeds have been treated or retreated by an acceptable method (chemical, biological, mechanical, cultural, manual) for the specific objective of controlling their spread and/or reducing their density (generally reported in increments of not less than 0.1 acre for chemical and mechanical treatment).

Threshold level: A dose or exposure below which there is no apparent or measurable adverse effect.

Toxicity: The inherent ability of an agent to affect living organisms adversely.

CHAPTER 6

RESPONSE TO DRAFT EIS COMMENTS

INTRODUCTION

This document summarizes issues and concerns from comments received on the Weed Management Draft EIS (DEIS), and identifies the agency's response to the concerns.

On August 18, 2006, the Notice of Availability appeared in the Federal Register. This officially started the 45-day comment period for the Draft EIS. A legal notice was published in Billings Gazette and Rapid City Journal on August 21, 2006 and August 22, 2006, respectively. On August 22, 2006 a news release was mailed to 14 newspapers[1]. Copies of the Draft EIS were mailed to 11 agencies and 23 individuals[2]. U.S. Fish and Wildlife Service concurred with the biological assessment (project file) on October 20, 2006 (concurrence letter included at the end of this chapter).

CHANGES BETWEEN THE DRAFT EIS AND THE FINAL EIS

Based on the public comments to and internal review of the Draft EIS, a few minor changes were made between the Draft EIS and Final EIS as follows: the water quality monitoring section in Chapter 2 was expanded to include water quality monitoring results from the West Fork of Rock Creek; a reference to an available water quality monitoring technique was included in Chapter 5, Reference Section; minor typographical corrections were made, minor tabular corrections in tables were made, a few scientific names were updated, some grammar errors were corrected, and some sentences were restructured for clarification; gravel pit weed prevention guidelines were clarified in Appendix D; updates on some biological agents were incorporated; Appendix C biological control section was expanded to allow for consideration of maintaining successful bio-control sites as a distribution sources for bio-agents; a more thorough discussion of weed spread vectors was incorporated into Appendix D; and a statement was added to page 3-49 requires surface water to be free from substances that create concentrations which are toxic or harmful to aquatic life per Montana Water Quality Standards.

COMMENTS ON THE DEIS AND AGENCY RESPONSE

The following content analysis is in compliance with the National Environmental Policy Act (NEPA) and is designed to inform responsible officials of the potential environmental consequences of this project. Comment letters, in their entirety[3], are included at the end of this chapter.

LIST OF PEOPLE WHO COMMENTED ON THE DEIS

Comment Letter #	Agency, Organization, or individuals	Date
1	Public Comment – Harding County Commissioners and Weed Supervisor	9/26/06
2	Public Comment – USDI, Office of Environmental Policy and Compliance	9/28/06
3	Public Comment – EPA Region 8	9/28/06
4	Public Comment – Glenn Gay; Gay Ranch, Inc.	9/28/06
5	Public Comment – USDI Bureau of Indian Affairs	9/21/06

Commenter 1

1-1. I am in support of the use of Alternative 1, which includes all IMP methods using existing weed control, use of new herbicides, herbicide use within the Absarokee-Beartooth Wilderness Area and aerial application outside the Wilderness Area.

---

[1] News Releases sent to Stillwater Co. News, Carbon Co. News, Lovell Chronicle, Billings Gazette, The Outlook, The Outpost, Yellowstone Co. News, Miles City Star, Powder River Examiner, Nation News, Bowman Co. Pioneer, Rapid City Journal, Independent Press, The Ekalaka Eagle Newspapers

[2] The DEIS mailing list was based upon responses from a March 24, 2006 notice to the mailing list for project scoping. This March mailing asked for response from those interested in staying on the project mailing list and what kind of format they wanted to receive (hard copy, compact disk, executive summary, and/or access via weblink).

[3] USDI, BIA Attachment to the Cover Letter is found in the project file.

Response: Thank you for your support for the preferred Alternative 1 which is use of all tools available in combating weed spread and infestations.

1-2. *Since weeds know no boundaries and flourish in disturbed ground, wilderness areas should not be exempt from treatment.*

Response: Treatment within the Wilderness Area is proposed under Alternatives 1 and 2 based on the reasons you listed.

1-3. *New herbicides are often times much more environmentally friendly and less hazardous to the applicator. They can be used close to or in water and in trees with no haying or grazing restrictions when applied according to label.*

Response: New and more environmentally friendly herbicides such as aminopyralid and aquatic herbicides have been analyzed under Alternative 1.

1-4. *It is less costly to control or eradicate small invasions instead of waiting until there area huge acreages of established weeds.*

Response: Economic impacts are related in Chapter 3 and confirm your observations. Alternative 1 addresses the most cost efficient options.

Commenter 2

2-1. *No Comments.*

Response: Thank you for your response.

Commenter 3

3-1. *The EPA supports the purpose and need of the Custer National Forest Weed Management Project to prevent and reduce the loss of native plant communities associated with the spread of weeds. EPA fully supports the need to minimize spread of noxious weeds, and we support the proposed improvements to the Custer National Forest's integrated weed management program, including use of new herbicides, and herbicide use within the Absaroka-Beartooth Wilderness Area, and aerial application of herbicides outside of Wilderness… The EPA is generally pleased with the proposed protection and prevention measures to be used during herbicide applications to help ensure the accuracy and safety of ground and aerial herbicide applications.*

Response: Thank you for your support for the preferred Alternative 1 which is use of all tools available in combating weed spread and infestations.

3-2. *While the DEIS includes excellent presentation and disclosure of information, we note that the DEIS only indicates that the interdisciplinary team <u>may</u> recommend that water quality monitoring be conducted. The DEIS does not clearly state that monitoring <u>will</u> be conducted where there are higher risks or potential impacts to sensitive water. We believe the health of downstream domestic, agricultural and recreational water users and the aquatic ecosystem should dictate some level of aquatics monitoring to document and verify that aqueous transport of herbicides, particularly picloram, which is highly mobile and toxic, does not occur. Monitoring is necessary to validate that herbicide application protocols and design criteria are effective in preventing herbicide transport to surface and ground waters, and may increase public confidence that chemical contamination of surface waters did not occur (i.e., select a stream with a high potential for herbicide drift for monitoring or high nearby treatment acreage, and if no herbicide is identified in this stream, you can better validate and extrapolate that mitigation measures were effective in preventing herbicide drift to other aquatic areas with lower intensity of treatments). We note that Table 4-10 shows that only 2.6% of the Forest is in a "high" risk class due to pesticide leachability and depth to ground water. Such high risk areas would*

be good candidates for water quality monitoring. We recommend a more definitive commitment to conducting water quality monitoring in high risk areas.

Response: The referenced statement, located in the Monitoring section of Chapter 2, follows:

Whenever there are is reason to suspect that herbicides may have entered water during a spraying operation (such as herbicides detected on drift cards, or if a spill occurred), an interdisciplinary team may recommend that water quality monitoring be conducted.

To disclose a more thorough analysis as suggested by the commenter, the above sentence was replaced with the following:

Until the City of Red Lodge started using a well for their water source, the West Fork of Rock Creek historically served as the main water source for the city of Red Lodge. This area also received annual picloram treatments on weeds (mostly spot treatments with minor amounts of broadcast treatment). Because of this association with domestic use of the West Fork of Rock Creek water, the Beartooth Ranger District annually conducted water quality sampling and monitoring for picloram between 1990 and 2004. This area is also considered to be at high risk to ground water contamination according to Chapter 4, Table 4 – 10 and the Ground Water Vulnerability map outlined in the Map section of the EIS. The design criteria and protocols used when treating weeds during this time period were similar to and somewhat less stringent than what is being proposed under the proposed action, Alternative 1. Test results have never shown any levels of picloram.

The following are situations of higher risk where an interdisciplinary team should evaluate whether or not water quality monitoring (surface or groundwater) is recommended for line officer support and approval. A high commitment to water quality monitoring in these high risk situations is strongly encouraged.

- *Whenever there is reason to suspect that herbicides may have entered water during a spraying operation (such as herbicides detected on drift cards, or if a spill occurred),*
- *In situations of large-scale broadcast treatment using persistent herbicides (i.e. picloram), especially within highly leachable soils and proximity of depth to ground water (see Chapter 4, Table 4–10), or in close proximity to surface waters*
- *When picloram levels approach the maximum allowable annual treatment acreage by watershed (sixth code level hydrologic unit – see Chapter 4, Table 4–14).*

3-3. *We also recommend including additional information on the probable causes of noxious and invasive weed invasion within the Custer National Forest by describing the more common mechanisms by which weeds spread. We believe an Integrated Weed Management program should strive to explain the reason(s) why noxious and invasive weeds are present, to improve public understanding of mechanisms and vectors for weed spread, and thus, gain public support to reduce activities that spread weeds and apply strategies to mitigate root causes. It is important for an Integrated Weed Management Program to include educational activities for industrial and recreational users to encourage and promote public assistance in weed prevention and control.*

Response: A more thorough discussion of weed spread vectors and weed susceptibility was included in Appendix D as a response to this comment.

3-4. *We also noticed that the preferred alternative includes only 5 acres or less of seeding. As you know, seeding can be very useful to stabilize disturbed areas by re-establishing desirable species that out compete weeds and retard weed infestation. It is not clear why the proposed acreage for seeding is so low. Can the extent of proposed cultural treatments (seeding) to stabilized disturbed lands to withstand weed infestations be increased?*

Response: The Forest Service agrees that seeding is an effective technique to minimize weed infestations and spread. Although we routinely seed fire suppression dozer lines (over 500 acres in native grass seed in 2006 alone) and some known weed infestations after wildfire events to

reduce erosion and minimize establishment of potential weed infestation, the wildfire events are not predictable. Five acres was identified as a reasonably foreseeable need due to some anticipated road work and disturbance. However, adaptive management under Alternative 1 allows for the amount of seeding to be increased as the need arises.

3-5. *We also observed that the Ashland District saw a net decrease in weed-infested acres from 1985 to 2006 (Table 1-1). We suggest including further discussion of the reasons behind this observation, since understanding of the reasons why the Ashland District experienced a decline in weed-infested acres may provide information helpful for effective weed management on other Custer National Forest Districts.*

Response: The 2006 inventory for the Ashland Ranger District is generally less than what was reflected in the 1985 inventory. This is due to successful broadcast treatment of spotted knapweed and continued treatment of spurge.

3-6. *Based on the procedures EPA uses to evaluate the adequacy of the information and the potential environmental impacts of the proposed action and alternatives in an EIS, the DEIS has been rated as Category L. (Lack of Objections).*

Response: Thank you for your review and findings.

3-7. *We commend the Custer National Forest for this comprehensive disclosure of weed management program information. We encourage you to make these Appendices available to herbicide applicators.*

Response: Thank you. The Forest Service intends to provide applicable Appendices to all herbicide applicators, contractors, and cooperators.

3-8. *We believe an effective noxious weed control program should include restrictions on motorized uses, particularly off-road uses. Off-road vehicles are designed to travel off-trail, disturbing soil, creating weed seedbeds, and dispersing seeds widely. Weed seed dispersal from non-motorized travel is of lesser concern because of fewer places to collect/transport seed, and the dispersal rate and distances along trails are less with non-motorized travel. Restrictions on motorized uses may also be needed after burning and harvest activities until native vegetation is re-established in the disturbed areas to reduce potential for weed infestation of the disturbed sites.*

It is particularly important to avoid motorized travel in remaining roadless areas, since roadless areas are often reservoirs of native plants, and limitations on motorized travel in such areas can protect such areas from weed invasion and avoid the subsequent need to treat weeds.

Response: Decisions that will not be made based on the analysis were outlined at the end of Chapter 1. They include changes in travel, road use and access. The Off Highway Vehicle (OHV) amendment for Region One was implemented in January 2001. Off road or trail use by OHVs is restricted and will reduce one vector of weed spread. The first year focused on public education of riders in the field. In 2002 the enforcement phase of the amendment results in citations instead of warnings. Preventative measures for recreation, Wilderness, and roadless areas are outlined in Appendix D under Prevention and Control Measures, section 2.

3-9. *In order to prevent the establishment and spread of noxious weeds in recreation areas (trailheads, toilet areas, etc.), it may be helpful to consider the use of mulch where foot traffic is high and revegetation is difficult or impossible. Additionally, aesthetic barriers and posted signs may be utilized to discourage foot traffic in sensitive areas.*

Response: In response to this comment, the following was added to page 3-19 in Chapter 3 section on seeding treatment and its effectiveness. "Use of mulching and/or barriers to travel paths in high use areas can make this treatment more effective."

3-10. *We are pleased to see the Weed Seed Free Feed and Straw Policy (page D-5). It can be helpful to require cattle and horses, especially those coming from areas with noxious weds, to be penned and*

fed weed free hay for several days prior to being released on public lands to prevent introduction of noxious weeds..

Response: Although it could be an encouraged practice where possible, requiring domestic animals to be penned and fed weed free hay prior to entering public lands is not feasible, especially during hunting season, when the use of horses is very high and the number of Forest Service staff is very limited.

3-11. *Forest wide programmatic direction should assure that the effects of burning on the potential stimulation of noxious weeds be evaluated during site-specific project level analysis. Prescribed fire has the potential to stimulate weed growth (e.g., Dalmatian toadflax or leafy spurge), and can destroy insects planted for biological weed control. Burning followed by application of appropriate herbicides can provide effective weed control. We suggest that such considerations be evaluated for during development of direction ad plans for prescribed burning.*

Response: Guidelines for weed control and the development of plans for prescribed burning are already addressed in the following Appendices: Appendix C outlines protection measures for burn plan development. Appendix D outlines the Forest Service protocol for assessing project risk. Appendix F describes treatment effectiveness by species. Appendix J describes burning effectiveness and guidelines by species.

3-12. *Sites selected for application of biological control agents should be protected from other management actions that could negatively influence the biocontrol agent (such as burning as noted above or application of toxic herbicides). Protected biocontrol sites can also function as collection points for redistribution of established biocontrols to other sites.*

Response: A criteria for selecting biological control sites is the probability that the site will not be disturbed. However, there are no guarantees that the site will not be disturbed. Many sites already function as collection points for redistribution. However, in response to this comment, the following was added to Table C - 1 in Appendix C biological control section. "Protected biocontrol sites can also function as collection points for redistribution of established biocontrols to other sites. Depending upon management objectives, consideration should be given for possible protection of successful biocontrol sites from other management actions that could negatively influence the biocontrol agent (such as burning or application of herbicides)."

3-13. *Spotted knapweed is identified as one of the more prevalent noxious weed species in the project area (page 3-5). We note that spotted knapweed is non-rhizomatous and should be relatively easy to control with lower rates of the most selective low toxicity herbicides.*

Response: This herbicide use strategy is already outlined in Appendix I, page I – 1.

3-14. *The Forest may also want to consider groundwater monitoring in selected wells in close proximity to applications sites.*

Response: Under Alternatives 1 and 3, the Custer National Forest has a low to moderate potential for groundwater contamination from foliar-applied herbicides (FEIS, page 4-41). The areas of higher risk can be mitigated with herbicide selection to minimize the contamination potential. The monitoring section on page 2-9 describes an adaptive approach to surface water, and if appropriate, ground water (well) monitoring.

3-15. *We note that bioassay techniques using aquatic species sensitive to the herbicides to be used are available for detecting aquatic impacts from herbicide applications (e.g. stoneflies, cutthroat trout). EPA has prepared a toxicity testing manual entitled, "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms", EPA/600/4-90/027, September 1991. Toxicity testing procedures are described in this manual, including procedures using rainbow and brook trout.*

Response: There are different monitoring techniques dependent upon the monitoring needs. In response to this comment, a footnote in Chapter 2 Monitoring section references EPA/600/4-90/027 web link found in Chapter 5 as an available testing technique.

3-16. *We are pleased that an adaptive management approach is identified in Appendix E, including identification of treatment priorities, a decision tree for treatment of new weed locations, guidelines for treatments, and a treatment effectiveness guide (Appendix F). As a general practice, EPA suggests prioritizing perimeter weed infestations such as around trailheads and roadside before treating interior weed infestations.*

Response: The Forest Service agrees with your suggested priority criteria. This is already addressed in Appendix E, Table E-1. However, if the trailhead or road is in the interior and considered a source for weed spread then these areas could also be considered a priority.

3-17. *The presentation of information regarding the herbicides proposed for use is helpful in evaluation of potential effects of herbicide applications (Table 3-10, Effects of Drift factors on Herbicide Drift, Table 3-11, Comparison of Herbicides, Table 3-13, Herbicide Behavior in Soils, Table 3-14, Montana Water Quality Human Health Standards for Herbicides, Appendices G, H, I, J & M). We recommend all applicators have access to these tables in the field.*

Response: The Forest Service intends to provide applicable Tables and Appendices to all herbicide applicators, contractors, and cooperators for field use.

3-18. *We are generally more concerned about applications of the more toxic, persistent, and mobile herbicides such as picloram (Tordon). As you know most picloram products, including Tordon 22K, are Restricted Use Pesticides requiring pesticide applicator certification to purchase and apply. It is important that U.S. Forest Service employees be certified throughout the duration of the project. If commercial applicators will be contracted for application of Restricted Use Pesticides, we recommend checking to make sure their MT commercial Restricted Use Pesticides license is current. Please contact Montana Dept. of Agriculture at (406) 444-5400 for more information.*

Response: The Custer National Forest routinely follows the state laws relative to pesticide use and application in both Montana and South Dakota. The Forest Service also ensures that contractors and cooperators are also certified for commercial Restricted Use Pesticides. This is also stated in Protection Measures outlined in Appendix C, Table C-1.

3-19. *We recommend that applications of more persistent, toxic herbicides such as picloram be limited to once per year to reduce potential for accumulation in soil. Trade-offs between effective weed control and effects on soil productivity and leaching concerns need to be considered. A second treatment application of picloram if needed should only occur after 30 days (or according to label directions).*

Response: It is important to carefully consider application rates of all herbicides, including those of the more persistent herbicides. The Forest Service expects all weed treatments to comply with label directions and Protection Measures outlined in Appendix C. Given the extent of weeds on Forest Service land, we question the effectiveness of, and need for multiple treatments per growing season. If there is a need for twice a year applications, then the total seasonal application of herbicide must not exceed the maximum application rate as defined in the specimen label.

3-20. *The Montana Department of Agriculture recommends that pesticide/herbicide applicators establish soil depth criteria with sufficient depth to ground water to mitigate the potential for the movement of leachable herbicides such as picloram or clopyralid to ground water (Donna Rise, MDA, phone 444-5400). Six feet of soil may be adequate if the soils are less permeable (e.g. clay) and may provide adequate time for picloram and clopyralid to degrade. Six feet of soil, however, will not be adequate if the soils are sandy, gravelly or have cobbly, stony, or other permeable structural characteristics. The Ground Water Information Center at the Montana Bureau of Mines & Geology in Butte, MT (406-496-4153) may have well log information for estimation of ground water levels in treatment areas.*

Response: The EIS acknowledges picloram and clopyralid as leachable herbicides (Chapter 3, Table 3-13, pages 3-45 through 3-48; Chapter 4, pages 4-40 through 4-42; and Appendix C). The majority of the Custer National Forest depth to ground water is greater than six feet. Where they are less than six feet are generally in wetlands and riparian areas which have specific protection measures outlined in Appendix C. Appendix C outlines criteria to be used for each herbicide under a variety of water/riparian/wetland related environments. Applicators can easily recognize riparian/wetland conditions, whereas use of soil/depth criteria for applicators are not a realistic criteria for applicators to use. This is also a reason the analysis included the use of the RAVE model and maps. The RAVE model accounts for soil depth and other soil characteristics which is part of the analysis outlined in Chapters 3 and 4 (pages listed above). Ground water vulnerability map, based on the RAVE model is also displayed in the Map Section.

3-21. *For your information, Dow AgroSciences, the manufacturer of Tordon 22K, has recently developed supplemental labeling for Tordon 22K for areas west of the Mississippi River. They have directions for wick or carpet roller applications. Tordon 22K herbicide can be applied using wick or carpet roller equipment where drift presents a hazard to susceptible crops, surface waters, and other sensitive areas. One part Tordon 22K is mixed with 2 parts water to prepare a 33% solution. The wick method of application is more labor intensive but very effective at targeting particular noxious weeds adjacent to surface waters, wetlands, or protected plants.*

Response: Thank you for the information. This information has been added to Appendix I, page I-1.

3-22. *Also, please note that registration for Access, picloram active ingredient, is cancelled and Appendix G (page G-1) should be updated.*

Response: Thank you for the information. This information was updated in Appendix G.

3-23. *Table 3-14 shows numeric Montana Water Quality Human Health Standards for herbicides, and a statement is included in the narrative that no aquatic life standards have been established (page 3-49). While it is correct that Montana Water Quality Standards do not include numerical criteria for aquatic life protection for the herbicides proposed for use (since research/data requirements necessary to establish numerical aquatic life water quality criteria are very rigorous), it is important to understand that many herbicides are toxic to aquatic life even though numerical aquatic life criteria have not been established. The Montana Water Quality Standards, however, do include a general narrative standard requiring surface water to be free from substances that create concentrations which are toxic or harmful to aquatic life. It would be helpful to present this important narrative "free from toxicity standard" in the final EIS.*

Response: Your comment has been incorporated into page 3-49.

3-24. *Weed infestations are often able to out-compete native vegetation in soils where overgrazing, fire, or other disturbance has depleted soil fertility levels. It may be useful to analyze for soil fertility parameters (pH, Ca, Mg, K, P, organic matter, %N). If soil fertility is low, it may be helpful to apply slow release fertilizers to initiate competitive growth of native vegetation. The Forest may also want to consider monitoring of herbicide concentrations in soils; and soil microbiologic assays; monitoring of plant communities; and monitoring of soil erosion and sedimentation rates.*

Response: Increasing fertility levels were not considered except for localized treatment of tall larkspur. However, use of fertilization in producing or maintaining healthy native vegetation, to assist competition with weeds, can be done under adaptive management as outlined under Alternative 1 and Appendix E.

Federal law and State water-quality standards set maximum concentration levels for various herbicides in water, but not in soil. The monitoring program emphasizes water to comply with state and federal laws and regulations. The fact that herbicides might appear in water is evidence that the application methods are causing migration of herbicides and could affect non-target plants

and animals. Many herbicides are intentionally designed to persist in soil so that they may control weeds throughout a growing season or longer. With limited resources, the Forest Service believes that monitoring water quality is more efficient and informative.

3-25. *There is always concern about the potential for pesticide contamination of surface and ground water, when pesticides (herbicides) are applied, since some pesticides may be harmful to humans and to fish and wildlife and to sensitive crops at very low concentrations. Also, clean-up of ground water supplies that have been contaminated by persistent pesticides can be very difficult, so it is best to avoid contamination in the first place.*

We are also pleased that the risk assessment for soils and ground water evidences a low risk of ground water contamination (page 4-43). The surface water risk analysis shows some potential for water quality risk with picloram treatments (page 4-53), however, we are pleased that it is stated that site-specific reassessments will be done during contract preparation for aerial applications, and if necessary treatment acres would be reduced to minimize water quality effects.

Response: The analysis included several protection measures (Appendix C) and prevention measures (Appendix D) to minimize the likelihood of herbicide contamination effects.

3-26. *Thank you for including the many tables with information on toxicity and hazards associated with herbicide use (e.g., Table 4-4, Human Hazards based on Acute Toxicity Categories, Table 4-5, Chronic Toxicity Summary, Table 4-6, Herbicide Toxicity Hazard Quotients for Workers, Table 4-13, Effects of Proposed Herbicides on Aquatic Organisms, Table 4-19, Mammalian Toxicity). We are pleased that the assessment of herbicide drift indicates no significant off-site drift with proposed mitigation measures (page 4-34), and no anticipated significant cumulative health effects.*

Response: Thank you for your review.

3-27. *Please be aware that certain pest control activities described in the DEIS may fall under EPA's Worker Protection Standard (WPS) if, (1) the U.S. Forest Service is the "employer" in control of the "operation" and the operation involves or is related to commercial production of timber or timber products, (2) the U.S. Forest Service is using WPS-labeled pesticides, and (3) the pesticide applications in question are related to the production of timber/timber products and they are not covered by one of the applicable exceptions or exemptions. If you have any questions regarding the WPS or its applicability please contact Jaslyn Dobrahner in the Denver EPA office at (303) 312-6252.*

Response: It is recognized that when using a pesticide product with labeling that refers to the Worker Protection Standard, one must comply with the WPS, as outlined in adhering to label instruction in Appendix C. However, applications on pastures, rangeland or livestock are exempt from the WPS and the use of herbicide analyzed in the EIS is not related to the production of timber or timber products.

3-28. *We are pleased that potential effects to fisheries, amphibians, wildlife and sensitive plants were also evaluated and disclosed in Chapters 3 and 4, with risk evaluation to wildlife on a herbicide-by-herbicide basis. Will Forest biologist and botanists conduct field surveys and identify potential habitats for sensitive and threatened and endangered fish and wildlife and plant species for each treatment area as part of the preparation of the each annual weed management operating plan? We did not see this mitigation measure specifically included in the protection or prevention measures. We suggest that it be included in Appendix C or D.*

Response: Weed coordinators review and coordinate with fisheries and wildlife biologists, and botanists to ensure species of concern are protected per protection measures outlined in Appendix C. If a new weed population is identified then the risk to sensitive plants, wildlife, or aquatic organisms will be evaluated through adaptive management approaches as identified in Appendix E of the EIS. Trained individuals will conduct any future surveys for species of concern.

3-29. *Thank you for discussion and analysis of potential effects on wildlife resource, including threatened and endangered species including Grizzly Bear, Gray Wolf, and Bald Eagle (page 4-60 to 4-81). We*

note that the final EIS should include the associated FWS Biological Opinion or formal concurrence for the following reasons: (1) NEPA requires public involvement and full disclosure of all issues upon which a decision is to be made; (2) the CEQ Regulations for implementing the Procedural Provisions of NEPA strongly encourage the integration of NEPA requirements with other environmental review and consultation requirements so that all procedures run concurrently; (3) the Endangered Species Act (ESA) consultation process can result in the identification of reasonable and prudent alternatives to preclude jeopardy, and mandated reasonable and prudent measures to reduce incidental take. These can affect project implementation.

Since the Biological Assessment and EIS must evaluate the potential impacts on listed species, they can jointly assist in analyzing the effectiveness of alternatives and mitigation measures. EPA recommends that final EIS and Record of Decision not be completed prior to the completion of ESA consultation. If the consultation process is treated as a separate process, the Agencies risk USFWS identification of additional significant impacts, new mitigation measures, or changes to the preferred alternative. If these changes have not been evaluated in the final EIS, a supplement to the EIS would be warranted.

Response: A Biological Assessment was prepared for the Selected Alternative. The deciding officer selects the alternative only after reviewing public comment on the Draft EIS. This Biological Assessment was submitted to the U.S. Fish & Wildlife Service as required under Section 7 of the Endangered Species Act. The resulting concurrence letter has been incorporated into the Final EIS. The Section 7 consultation was completed prior to the issuance of the final EIS and Record Of Decision.

Commenter 4

4-1. I support Alternative 1 as discussed in the Draft EIS. The only way to control the relentless invasion of noxious weeds is with a coordinated effort using chemical, biological, and cultural methods. The EIS has a comprehensive discussion of the various methods proposed with a realistic prediction of the outcome. The environmental impacts of the various methods are adequately analyzed.

Response: Thank you for your support for the preferred Alternative 1 which is use of all tools available in combating weed spread and infestations.

4-2 I have been releasing the various Aphthona leafy spurge flea beetles on this ranch and in the Powder River Breaks area since 1990. The last two years, I have not found a leafy spurge infestation in this area that does not have flea beetles. Biocontrol is slow but the beetles are established and will help slow the spread of leafy spurge.

Response: Use of Aphthona leafy spurge flea beetles were analyzed in the DEIS in chapters 3 and 4, along with Appendix I. The Forest Service agrees with your observations and appreciates the biological control work you have been doing in the Bloom Creek / Powder River Breaks over the past few years.

4-3 Chemical or cultural control should be used in the areas where the noxious weeds are not established and can be eliminated. Biocontrol is too slow and will allow the noxious weed to become established.

Response: Alternative 1 addresses the integration of chemical, cultural, and biological control techniques for effective control and/or containment. Alternative 2 describes that biological control and/or cultural treatments, without herbicide use, is not effective for an overall program for weed management. However, it is recognized that in some circumstances, the location, size, density, and species may determine that biological control be used as a site specific strategy.

Appendix E outlines priorities for weed treatments. This appendix also displays a decision tree to help one quickly and effectively treat newly discovered weed infestations, based on site characteristics, weed species, and location. The analysis in Appendix E also addresses adaptive management strategies to improve effectiveness and reduce impacts through use of new technologies, biological controls, adjuvants, or herbicides.

Commenter 5

5-1. *Copies of the pages of the DEIS with specific comments are enclosed for your review and use. These comments do not address the merits of the alternatives, but are more directed at the content and presentation of the information.*

Response: The commenter thoroughly identified typographical corrections, minor tabular corrections in tables, scientific naming nomenclature updates, grammar corrections, and sentences needing restructuring for clarification. These comments were incorporated into the Final EIS.

Substantive comments on additional information on specific biological agents and their effectiveness were also included in biological control portions of Chapter 3 and 4, and Appendix I.

Chapter 3, Table 3 – 2 infestation acreage within the Sweet Grass portion of the Custer National Forest were corrected to reflect 295.8 gross acres and 8.1 infested acres.

COMMENT LETTERS

(1)

DEIS for Custer National Forest Weed Management

I support the use of Alternative 1, which includes all IMP methods using existing weed control, use of new herbicides, herbicide use within the Absorkee-Beartooth Wilderness Area and aerial application outside the Wilderness Area.

If we are going to be successful in the fight on noxious weed infestations, we must use everything available to us. Since weeds know no boundaries and flourish in disturbed ground, wilderness areas should not be exempt from treatment. New herbicides are often times much more environmentally friendly and less hazardous to the applicator. They can be used close to or in water and in times with no haying or grazing restrictions when applied according to the label. It is less costly to control or eradicate small invasions instead of waiting until there are huge acreages of established weeds.

Mary Tarter Mary Tarter

Harding County Weed and Pest Supervisor September 26, 2006
Harding County Weed and Pest Board
Box 146
Buffalo, SD 57720
1-605-375-3412

Robert W. Johnson, Chairman
Robert W Johnson
Harding County Commission September 26, 2006
Box 26, Buffalo, SD 57720
1-605-375-3313

(2)

United States Department of the Interior

OFFICE OF THE SECRETARY
Office of Environmental Policy and Compliance
Denver Federal Center, Building 56, Room 1003
Post Office Box 25007 (D-108)
Denver, Colorado 80225-0007

TAKE PRIDE IN AMERICA

September 28, 2006

9043.1
ER 06/810

Nancy T. Curriden, Forest Supervisor
Custer National Forest
1310 Main Street
Billings, Montana 59105

Dear Ms. Curriden:

The Department of the Interior (Department) has reviewed the Draft Environmental Impact Statement (DEIS) for the Custer National Forest Weed Management Project, Custer National Forest, and has no comments.

Sincerely,

Barbara M. Schmalz
for Robert F. Stewart
Regional Environmental Officer

cc: Kim Reid, Project Coordinator Leader

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 8, MONTANA OFFICE
FEDERAL BUILDING, 10 West 15th St., Suite 3200
HELENA, MONTANA 59626

(3)

Ref: 8MO

September 25 2006

Ms. Nancy T. Curriden, Forest Supervisor
Att: Kim Reid, Project Coordinator
Custer National Forest
1310 Main Street
Billings, MT 59105

Re: CEQ 20060340; Custer National Forest Weed Management Draft Environmental Impact Statement

Dear Ms Curriden:

The Environmental Protection Agency (EPA) Region VIII Montana Office has reviewed the Draft Environmental Impact Statement (DEIS) for the Custer National Forest Weed Management Project in accordance with its responsibilities under the National Environmental Policy Act (NEPA) and Section 309 of the Clean Air Act. Section 309 of the Clean Air Act directs EPA to review and comment in writing on the environmental impacts of any major Federal agency action. The EPA's comments include a rating of the environmental impact of the proposed action and the adequacy of the NEPA document.

The EPA supports the purpose and need of the Custer National Forest Weed Management Project to prevent and reduce the loss of native plant communities associated with the spread of weeds. EPA fully supports the need to minimize spread of noxious weeds, and we support the proposed improvements to the Custer National Forest's integrated weed management program, including use of new herbicides, and herbicide use within the Absaroka- Beartooth Wilderness Area, and aerial application of herbicides outside of Wilderness. Noxious weeds are a great threat to biodiversity, and can out-compete native plants and produce a monoculture that has little or no plant species diversity or benefit to wildlife. Given increasing concerns about weed invasion, we recognize the utility of cost-effective methods of weed management such as using newer herbicides, application within infested areas within the Wilderness to prevent wider infestations, and carefully managed aerial application of herbicides. Aerial applications are cost-effective where there are areas of weed infestation across steep and inaccessible terrain.

However, we want to emphasize the importance of incorporating adequate measures into ground and aerial herbicide applications to mitigate risks of adverse health and environmental effects (e.g., avoid drift of potentially toxic herbicides to aquatic areas

Printed on Recycled Paper

or other sensitive areas and impacts to non-target plants). The proposed herbicide application protection measures, prevention practices, BMPs, aerial spray guidelines and drift model results and other mitigation measures identified in the DEIS Appendices evidence clear recognition of the need to avoid drift of herbicides to non-target areas. EPA is generally pleased with the proposed protection and prevention measures to be used during herbicide applications to help ensure the accuracy and safety of ground and aerial herbicide applications.

In fact, the DEIS includes one of the most comprehensive sets of Appendices presenting weed management mitigation measures, data and information that we have seen. The numerous Appendices, many informative tables, and narrative discussions in the DEIS provide valuable information that greatly improves pubic understanding of proposed Custer National Forest weed management activities, and facilitates review and evaluation of proposed activities. We commend the Custer National Forest for this comprehensive and informative analysis and disclosure regarding the proposed weed management program.

While the DEIS includes excellent presentation and disclosure of information, we note that the DEIS only indicates that the interdisciplinary team may recommend that water quality monitoring be conducted. The DEIS does not clearly state that monitoring will be conducted where there are higher risks or potential impacts to sensitive waters. We believe the health of downstream domestic, agricultural and recreational water users and the aquatic ecosystem should dictate some level of aquatics monitoring to document and verify that aqueous transport of herbicides, particularly picloram, which is highly mobile and toxic, does not occur. Monitoring is necessary to validate that herbicide application protocols and design criteria are effective in preventing herbicide transport to surface and ground waters, and may increase public confidence that chemical contamination of surface waters did not occur (i.e., select a stream with a high potential for herbicide drift for monitoring or high nearby treatment acreage, and if no herbicide is identified in this stream, you can better validate and extrapolate that mitigation measures were effective in preventing herbicide drift to other aquatic areas with lower intensity of treatments). We note that Table 4-10 shows that only 2.6% of the Forest is in a "high" risk class due to pesticide leachability and depth to ground water. Such high risk areas would be good candidates for water quality monitoring. We recommend a more definitive commitment to conducting water quality monitoring in high risk areas.

We also recommend including additional information on the probable causes of noxious and invasive weed invasion within the Custer National Forest by describing the more common mechanisms by which weeds spread. We believe an Integrated Weed Management program should strive to explain the reason(s) why noxious and invasive weeds are present, to improve public understanding of mechanisms and vectors for weed spread, and thus, gain public support to reduce activities that spread weeds and apply strategies to mitigate root causes. It is important for an Integrated Weed Management Program to include educational activities for industrial and recreational users to encourage and promote public assistance in weed prevention and control.

We also noticed that the preferred alternative includes only 5 acres or less of seeding. As you know, seeding can be very useful to stabilize disturbed areas by re-establishing desirable

species that out compete weeds and retard weed infestation. It is not clear why the proposed acreage for seeding is so low. Can the extent of proposed cultural treatments (seeding) to stabilize disturbed lands to withstand weed infestations be increased?

We also observed that the Ashland District saw a net decrease in weed-infested acres from 1985 to 2006 (Table 1-1). We suggest including further discussion of the reasons behind this observation, since understanding of the reasons why the Ashland District experienced a decline in weed-infested acres may provide information helpful for effective weed management on other Custer National Forest Districts.

Our more detailed comments, questions, and concerns regarding the analysis, documentation, and/or potential environmental impacts of the Custer National Forest Weed Management Project DEIS are enclosed for your review and consideration as you complete the Final Environmental Impact Statement (FEIS). Based on the procedures EPA uses to evaluate the adequacy of the information and the potential environmental impacts of the proposed action and alternatives in an EIS, the DEIS has been rated as Category LO (Lack of Objections). A copy of EPA's rating criteria is attached.

EPA concurs with the need for an expanded integrated weed management program to prevent the establishment and spread of weeds, including aerial application of herbicides. EPA did not identify any potential environmental impacts requiring substantive changes to the proposal, although EPA recommended that additional information on the causes of weed spread, additional cultural weed control methods (seeding), and a more definitive commitment to aquatic monitoring be considered.

The EPA appreciates the opportunity to review and comment on the DEIS. If we may provide further explanation of our concerns please contact Mr. Steve Potts of my staff in Helena at (406) 457-5022 or in Missoula at 406-329-3313.

Sincerely,

John F. Wardell
Director
Montana Office

Enclosures

cc: Larry Svoboda/Julia Johnson, EPA, 8EPR-N, Denver
Donna Rise, Montana Dept. of Agriculture, Helena
Mark Kelley, MDEQ, Helena

3

U.S. Environmental Protection Agency Rating System for Draft Environmental Impact Statements
Definitions and Follow-Up Action*

Environmental Impact of the Action

LO - - Lack of Objections: The Environmental Protection Agency (EPA) review has not identified any potential environmental impacts requiring substantive changes to the proposal. The review may have disclosed opportunities for application of mitigation measures that could be accomplished with no more than minor changes to the proposal.

EC - - Environmental Concerns: The EPA review has identified environmental impacts that should be avoided in order to fully protect the environment. Corrective measures may require changes to the preferred alternative or application of mitigation measures that can reduce these impacts.

EO - - Environmental Objections: The EPA review has identified significant environmental impacts that should be avoided in order to provide adequate protection for the environment. Corrective measures may require substantial changes to the preferred alternative or consideration of some other project alternative (including the no-action alternative or a new alternative). EPA intends to work with the lead agency to reduce these impacts.

EU - - Environmentally Unsatisfactory: The EPA review has identified adverse environmental impacts that are of sufficient magnitude that they are unsatisfactory from the standpoint of public health or welfare or environmental quality. EPA intends to work with the lead agency to reduce these impacts. If the potential unsatisfactory impacts are not corrected at the final EIS stage, this proposal will be recommended for referral to the Council on Environmental Quality (CEQ).

Adequacy of the Impact Statement

Category 1 - - Adequate: EPA believes the draft EIS adequately sets forth the environmental impact(s) of the preferred alternative and those of the alternatives reasonably available to the project or action. No further analysis of data collection is necessary, but the reviewer may suggest the addition of clarifying language or information.

Category 2 - - Insufficient Information: The draft EIS does not contain sufficient information for EPA to fully assess environmental impacts that should be avoided in order to fully protect the environment, or the EPA reviewer has identified new reasonably available alternatives that are within the spectrum of alternatives analyzed in the draft EIS, which could reduce the environmental impacts of the action. The identified additional information, data, analyses or discussion should be included in the final EIS.

Category 3 - - Inadequate: EPA does not believe that the draft EIS adequately assesses potentially significant environmental impacts of the action, or the EPA reviewer has identified new, reasonably available alternatives that are outside of the spectrum of alternatives analyzed in the draft EIS, which should be analyzed in order to reduce the potentially significant environmental impacts. EPA believes that the identified additional information, data, analyses, or discussions are of such a magnitude that they should have full public review at a draft stage. EPA does not believe that the draft EIS is adequate for the purposes of the National Environmental Policy Act and or Section 309 review, and thus should be formally revised and made available for public comment in a supplemental or revised draft EIS. On the basis of the potential significant impacts involved, this proposal could be a candidate for referral to the CEQ.

* From EPA Manual 1640 Policy and Procedures for the Review of Federal Actions Impacting the Environment February, 1987.

EPA Comments on Custer National Forest Weed Management Draft Environmental Impact Statement

BRIEF PROJECT OVERVIEW:

The Custer National Forest (CNF) prepared this DEIS to evaluate a proposal to implement specific invasive weed treatments on approximately 14,000 gross managed acres (1,500 net treatment acres) in support of the 1987 Forest Plan, agency policy, Executive Order 13112, and other public land laws, rules, and regulations; and disclose the environmental effects of expansion of the current weed control program. The current weed management program did not authorize use of herbicides in the Absaroka - Beartooth Wilderness Area, and did not analyze effects of new herbicides or aerial application of herbicides.

Custer National Forest lands in south central and southeastern Montana, and northwestern South Dakota encompass about 1.2 million acres and share boundaries with Yellowstone National Park, Bighorn National Recreation Area, Bureau of Land Management, the state border with Wyoming, the Gallatin and Shoshone National Forests, the Crow and Northern Cheyenne Indian Reservations, and numerous state and private lands. The project area covers the entire Custer National Forest, and includes existing, as well as future potential weed infestation areas. This analysis will assess forest-wide treatment effects, and application of adaptive management strategies for new weed infestations. Three alternatives have been developed to address these objectives.

Alternative 1 includes all integrated pest management (IPM) methods used for existing weed control, use of new herbicides, herbicide use within the Absaroka- Beartooth Wilderness Area, and aerial application of herbicides outside of Wilderness. This includes ground herbicide application on 1415 acres (including 45 acres in AB wilderness area); 85 acres of aerial herbicide application; 155 acres of biological control; less than 5 acres of hand pulling; less than 5 acres of seeding; 60 acres of tall larkspur herbicide treatments; and less than 5 acres of treatment along paved roads and other infrastructure construction, all within a 15 year period. The preferred alternative is Alternative 1.

Alternative 2 is to use all integrated pest management methods as outlined in Alternative 1, but without the use of herbicides (155 acres of biological control; less than 5 acres of hand pulling; less than 5 acres of seeding; 60 acres of tall larkspur treatments with sheep).

Alternative 3 takes no action to change the current integrated pest management identified in the 1987 Custer Forest Noxious Weed Control EIS, including ground based herbicide treatment with only four herbicide choices (2,4-D, picloram, dicamba, and glyphosphate), and no herbicide use within the A-B Wilderness Area.

1

COMMENTS:

1. The EPA supports the purpose and need of the Custer National Forest Weed Management Project to prevent and reduce the loss of native plant communities associated with the spread of weeds (page1-3). EPA fully supports the need to minimize spread of noxious weeds. Noxious weeds are a great threat to biodiversity, and can out-compete native plants and produce a monoculture that has little or no plant species diversity or benefit to wildlife. Impacts to native plant communities are much reduced when control actions are taken at an early stage of invasion.

   We support the proposed improvements of the Custer National Forest's integrated weed management program, including use of new herbicides, and herbicide use within the Absaroka- Beartooth Wilderness Area, and aerial application of herbicides outside of Wilderness. Use of an expanded list of herbicides and applications within infested portions of the Wilderness Area, along with carefully managed aerial applications of herbicides outside the Wilderness Area are likely to facilitate more effective weed management. Aerial applications are cost-effective where there are areas of weed infestation across steep and inaccessible terrain (Tables 3-21 to 3-24).

   The relative effectiveness of Alternative 1 using integrated weed management, including herbicide applications in comparison to Alternative 2 (without herbicide applications), and Alternative 3 (using only ground based herbicide treatments with only four herbicide choices, and no herbicide use within the A-B Wilderness Area) is evident from review of Table 2-3, Summary of Potential Impacts Between Alternatives (page 2-10), and from the cost analysis tables in Chapter 3 (Tables 3-21 to 3-24).

   Given increasing concerns about weed invasion, we recognize the utility of cost-effective methods of weed management such as using newer herbicides, application within infested areas within the Wilderness to prevent wider infestations, and carefully managed aerial application of herbicides. We want to also emphasize the importance of incorporating adequate measures into ground and aerial herbicide applications to mitigate risks of adverse health and environmental effects (e.g., avoid drift of potentially toxic herbicides to aquatic areas or other sensitive areas and impacts to non-target plants).

2. We appreciate the inclusion of a map section in the DEIS with many maps showing alternatives, proposed treatment areas, and Relative Aquifer Vulnerability Evaluations for Herbicide Contamination. We also appreciate the many informative and comprehensive Appendices in the DEIS that include useful information as follows:

   -*Weed species of concern and invasive species in or near the Forest* (Appendices A & B);
   -*Protection measures* (Appendix C);
   -*Prevention, risk assessment and BMPs* (Appendix D);

2

-*Treatment priorities* (Appendix E);
-*Effectiveness of treatments by species* (Appendix F);
-*Herbicide trade names and target species* (Appendix G);
-*Grazing restrictions by herbicide* (Appendix H);
-*Herbicide application rates* (Appendix I);
-*Herbicide efficacy* (Appendix J);
-*Calibration information* (Appendix K);
-*Maintenance, cleaning and storage of sprayers* (Appendix L);
-*Herbicide safety* (Appendix M);
-*Aerial spray guidelines and drift model results* (Appendix N).

This is one of the most impressive sets of Appendices presenting weed management program mitigation measures, data and information that we have seen. The maps and numerous Appendices and narrative discussions provide valuable information that greatly improves public understanding of the proposed Custer National Forest weed management activities, and facilitates review and evaluation of proposed activities.

We commend the Custer National Forest for this comprehensive disclosure of weed management program information. We encourage you to make these Appendices available to herbicide applicators.

3. The Appendix C protection measures, Appendix D prevention practices and BMPs, and Appendix N aerial spray guidelines and drift model results, evidence clear recognition of the need to avoid drift of herbicides to non-target areas. EPA is generally pleased with the proposed protection and preventative measures to be used during herbicide applications to help ensure the accuracy and safety of ground and aerial herbicide applications.

We support the proposed 300 foot buffer for aerial applications around streams and wetlands, and for including other measures to reduce risk of herbicide drift to sensitive areas. Herbicide drift into streams and wetlands could adversely affect aquatic life and wetland functions such as food chain support and habitat for wetland species. We believe a 300 feet buffer provides an appropriate safety zone to reduce risk of drift and runoff of potentially toxic herbicides to streams and wetlands during aerial applications. A buffer zone is particularly important for streams with valuable or sensitive fisheries resources (e.g., yellowstone cutthroat trout) or where there are downstream public water supplies.

We are also appreciative of the many other proposed measures to minimize risk of herbicide drift to sensitive areas (e.g., wind monitoring; use drift cards, dyes, drift reduction agents, spray nozzles that produce larger droplets, etc.).

4. We particularly appreciate the attention given to prevention practices and BMPs for weed control (Appendix D), since weed prevention is often the most cost-effective way to

3

manage and control weeds by avoiding new infestations and spread of weeds, and thus, avoiding the need for subsequent weed treatments (e.g., revegetation of disturbed areas, use of weed free seed, cleaning vehicles and equipment, and other practices that prevent infestation and spread of weeds). Early recognition and control of new infestations avoids wider future use of herbicides and other control methods. Weed prevention is a critical component in a weed management program.

5. The discussion and presentation of information on weed species, weed biology, vulnerability to infestations and rate of spread, treatment methods, and risk assessment in Chapter 3 and weed species specific ecology and IPM treatments in Appendix I are very informative. This type of information is an important part of an effective IPM program, and we are pleased to see so much valuable information included in the DEIS.

Noxious weeds tend to gain a foothold where there is disturbance in the ecosystem (e.g., logging sites, construction sites, road building, soil disturbance, fire, motorized travel, recreation, livestock grazing, etc.,). We believe an Integrated Weed Management program should strive to explain the reason(s) why noxious and invasive weeds are present, to improve public understanding of mechanisms and vectors for weed spread. We, therefore, suggest including additional discussion on the probable causes of noxious and invasive weed invasion within the Custer National Forest. By describing the more common mechanisms by which weeds spread, the Custer National Forest may be better able to gain public support to reduce activities that spread weeds and better apply strategies to mitigate root causes. It is important for an integrated Weed Management Program to include educational activities for industrial and recreational users to encourage and promote public assistance in weed prevention and control.

For example, weed seeds are transported by wind and water, animal fur, feathers and feces, but primarily by people. The greatest vector for spread of weeds is through motorized vehicles-cars, trucks, ATVs, motorcycles, and even snowmobiles. Weed seeds are often caught on the vehicle undercarriage in mud and released on the Forest. A single vehicle driven several feet through a knapweed site can acquire up to 2,000 seeds, 200 of which may still be attached after 10 miles of driving (Montana Knapweeds: Identification, Biology and Management, MSU Extension Service).

We believe an effective noxious weed control program should include restrictions on motorized uses, particularly off-road uses. Off-road vehicles are designed to travel off-trail, disturbing soil, creating weed seedbeds, and dispersing seeds widely. Weed seed dispersal from non-motorized travel is of lesser concern because of fewer places to collect/transport seed, and the dispersal rate and distances along trails are less with non-motorized travel. Restrictions on motorized uses may also be needed after burning and harvest activities until native vegetation is reestablished in the disturbed areas to reduce potential for weed infestation of the disturbed sites.

4

It is particularly important to avoid motorized travel in remaining roadless areas, since roadless areas are often reservoirs of native plants, and limitations on motorized travel in such areas can protect such areas from weed invasion and avoid the subsequent need to treat weeds.

6. We noticed that the preferred alternative includes 5 acres or less of cultural treatments (seeding, page 2-5). As you know, seeding can be very useful to stabilize disturbed areas by re-establishing desirable species that out compete weeds and retard weed infestation (page 3-18). It is not clear why the proposed acreage for seeding is so low. Can the extent of proposed cultural treatments (seeding) to stabilize disturbed lands to withstand weed infestations be increased? It is important that disturbed sites be seeded as soon as possible after disturbance to reduce potential for weed establishment. The goal of the seeding program should be to establish the sustainability of the area.

7. In order to prevent the establishment and spread of noxious weeds in recreation areas (trailheads, toilet areas, etc...), it may be helpful to consider the use of mulch where foot traffic is high and revegetation is difficult or impossible. Additionally, aesthetic barriers and posted signs may be utilized to discourage foot traffic in sensitive areas.

8. According to information in Table 1-1 (page 1-5), the Ashland District saw a net decrease in weed-infested acres from 1985 to 2006. We suggest including further discussion of this observation, since understanding of the reasons why the Ashland District experienced a decline in weed-infested acres may provide information helpful for effective weed management on other Custer National Forest Districts.

9. We are pleased to see the *Weed Seed Free Feed and Straw Policy* (page D-5). It can be helpful to require cattle and horses, especially those coming from areas with noxious weeds, to be penned and fed weed free hay for several days prior to being released on public lands to prevent introduction of noxious weeds.

10. Forest wide programmatic direction should assure that the effects of burning on the potential stimulation of noxious weeds be evaluated during site-specific project level analysis. Prescribed fire has the potential to stimulate weed growth (e.g., Dalmatian toadflax or leafy spurge), and can destroy insects planted for biological weed control. Burning followed by application of appropriate herbicides can provide effective weed control. We suggest that such considerations be evaluated for during development of direction and plans for prescribed burning.

11. Sites selected for application of biological control agents should be protected from other management actions that could negatively influence the biocontrol agent (such as burning as noted above, or application of toxic herbicides). Protected biocontrol sites can also function as collection points for redistribution of established biocontrols to other sites.

5

12. Spotted knapweed is identified as one of the more prevalent noxious weed species in the project area (page 3-5). We note that spotted knapweed is non-rhizomatous and should be relatively easy to control with lower rates of the most selective low toxicity herbicides.

13. It is important to monitor results of weed treatment activities to document and assure effective weed treatment with minimal impacts on non-target species and avoidance of other adverse environmental or public health effects. Monitoring should be an integral part of the weed management program. EPA is pleased to see (page 2-8) that the Custer National Forest would incorporate monitoring into each alternative focusing on the: 1) density and rate of weed spread and their effects; 2) effects of herbicides on noxious weeds; 3) establishment and effectiveness of biological control agents; 4) presence of herbicide in surface or ground water in high risk areas (i.e. accidental spills, aerial application), and 5) implementation of protection measures.

We believe the health of downstream domestic, agricultural and recreational water users and of the aquatic ecosystem should dictate some level of aquatics monitoring to document and verify that aqueous transport of herbicides, particularly picloram, which is highly mobile and toxic, does not occur. Monitoring is necessary to validate that herbicide application protocols and design criteria are effective in preventing herbicide transport to surface and ground waters, and may increase public confidence that chemical contamination of surface waters did not occur. We are pleased that sensitive resources (streams, lakes, wetlands and sensitive plants) would be monitored, and that spray detection cards would be used to evaluate herbicide drift towards sensitive resources (page 2-9).

We support monitoring of water samples where there higher probability for herbicide transport to surface or ground waters, and collection of water samples after the first substantial rain to detect the presence of herbicides from leaching or runoff. We suggest focusing monitoring on waters in high risk watersheds with increased risk factors such as: higher levels of herbicide applications; applications in close proximity to surface waters or areas with porous soils and high groundwater levels; herbicide applications near sensitive fisheries and near public water supplies, etc.. Monitoring of higher risk and more sensitive waters can validate that herbicide transport to aquatic areas does not occur, particularly monitoring for picloram and clopyralid, since these herbicides are highly soluble and mobile, and relatively persistent and toxic (i.e., select a stream with a high potential for herbicide drift for monitoring or high nearby treatment acreage, and if no herbicide is identified in this stream, you can better validate and extrapolate that mitigation measures were effective in preventing herbicide drift to other aquatic areas with lower intensity of treatments). The Forest may also want to consider groundwater monitoring in selected wells in close proximity to application sites.

While the Custer National Forest Weed Management DEIS includes excellent presentation and disclosure of information, the DEIS only indicates that the

6

interdisciplinary team may recommend that water quality monitoring may be conducted. The DEIS does not clearly state that monitoring will be conducted where there are higher risks or potential impacts to sensitive waters. We note that Table 4-10 (page 4-40) shows that only 2.6% of the Forest is in a "high" risk class due to pesticide leachability and depth to ground water. Such high risk areas would be candidates for water quality monitoring. We recommend a more definitive commitment to conducting water quality monitoring in high risk areas be included in the FEIS.

We note that bioassay techniques using aquatic species sensitive to the herbicides to be used are available for detecting aquatic impacts from herbicide applications (e.g., stoneflies, cutthroat trout). EPA has prepared a toxicity testing manual entitled, "Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms", EPA/600/4-90/027, September 1991. Toxicity testing procedures are described in this manual, including procedures using rainbow and brook trout.

14. We are pleased that an adaptive management approach is identified in Appendix E, including identification of treatment priorities, a decision tree for treatment of new weed locations, guidelines for treatments, and a treatment effectiveness guide (Appendix F). As a general practice, EPA suggests prioritizing perimeter weed infestations such as around trailheads and roadsides before treating interior weed infestations.

Thank you for including pre- and post-evaluations of effectiveness for all weed control projects. Evaluation of the effectiveness of treatments is critical to the long-term success of the program. Non-effective treatments need to be re-evaluated and potentially replaced with other treatment methods. All treatment methods used should be tracked to provide a comparison of the effectiveness of control measures, and weed infestations and control actions should be tracked in a Forest-level weed database. The Custer NF Weed Management program appears consistent with these concepts.

15. The presentation of information regarding the herbicides proposed for use is helpful in evaluation of potential effects of herbicide applications (Table 3-10, *Effects of Drift Factors on Herbicide Drift*, Table 3-11, *Comparison of Herbicides*, Table 3-13, *Herbicide Behavior in Soils*, Table 3-14, *Montana Water Quality Human Health Standards for Herbicides*, Appendices G, H, I, J & M). We recommend all applicators have access to these tables in the field.

16. We are generally more concerned about applications of the more toxic, persistent, and mobile herbicides such as picloram (Tordon). As you know most picloram products, including Tordon 22K, are Restricted Use Pesticides requiring pesticide applicator certification to purchase and apply. It is important that U.S. Forest Service employees be certified throughout the duration of the project. If commercial applicators will be contracted for application of Restricted Use Pesticides, we recommend checking to make

7

sure their MT commercial Restricted Use Pesticides license is current. Please contact Montana Dept. of Agriculture at (406) 444-5400 for more information.

We recommend that applications of more persistent, toxic herbicides such as picloram be limited to once per year to reduce potential for accumulation in soil. Trade-offs between effective weed control and effects on soil productivity and leaching concerns need to be considered. A second treatment application of picloram if needed should only occur after 30 days (or according to label directions).

The Montana Department of Agriculture recommends that pesticide/herbicide applicators establish soil depth criteria with sufficient depth to ground water to mitigate the potential for the movement of leachable herbicides such as picloram or clopyralid to ground water (Donna Rise, MDA, phone 444-5400). Six feet of soil may be adequate if the soils are less permeable (e.g., clay) and may provide adequate time for picloram and clopyralid to degrade. Six feet of soil, however, will not be adequate if the soils are sandy, gravelly or have cobbly, stony, or other permeable structural characteristics. The Ground Water Information Center at the Montana Bureau of Mines & Geology in Butte, MT (406-496-4153) may have well log information for estimation of ground water levels in treatment areas.

17. For your information, Dow AgroSciences, the manufacturer of Tordon 22K, has recently developed supplemental labeling for Tordon 22K for areas west of the Mississippi River. They have directions for wick or carpet roller applications. Tordon 22K herbicide can be applied using wick or carpet roller equipment where drift presents a hazard to susceptible crops, surface waters, and other sensitive areas. One part Tordon 22K is mixed with 2 parts water to prepare a 33% solution. The wick method of application is more labor intensive but very effective at targeting particular noxious weeds adjacent to surface waters, wetlands, or protected plants.

Also, please note that registration for Access, picloram active ingredient, is cancelled and Appendix E (page G-1) should be updated.

18. Thank you for providing detailed information on potential effects to soils and ground water and water quality effects (starting on page 3-44), and presenting results of relative aquifer vulnerability evaluations (RAVE) in Chapter 4 (starting on page 4-40).

Table 3-14 shows numeric Montana Water Quality Human Health Standards for herbicides, and a statement is included in the narrative that no aquatic life standards have been established (page 3-49). While it is correct that Montana Water Quality Standards do not include numerical criteria for aquatic life protection for the herbicides proposed for use (since research/data requirements necessary to establish numerical aquatic life water quality criteria are very rigorous), it is important to understand that many herbicides are toxic to aquatic life even though numerical aquatic life criteria have not

8

been established. The Montana Water Quality Standards, however, do include a general narrative standard requiring surface waters to *be free from substances that create concentrations which are toxic or harmful to aquatic life*. It would be helpful to present this important narrative "free from toxicity standard" in the final EIS.

19. Table 4-10 shows that only 2.6% of the areas are in a "high" risk category and no areas are in the "unacceptable" risk category, and it is stated that pesticide leachability and high ground water account for the few "high" risk ratings (page 4-41). We are pleased that almost all of the Forest is in the "low" or "low to moderate" risk class.

As noted in our comment #16 above, we are more concerned about applications of the more toxic, persistent, and mobile herbicides such as picloram (Tordon). Trade-offs between effective weed control and effects on soil productivity and leaching herbicide transport and contamination concerns need to be considered. While the DEIS does not show adverse effects on soil productivity from proposed herbicide use, we recommend that applications of more persistent herbicides such as picloram be limited to once per year to reduce potential for accumulation in soil. A second treatment application if needed should only occur after 30 days (or according to label directions).

Weed infestations are often able to out compete native vegetation in soils where overgrazing, fire, or other disturbance has depleted soil fertility levels. It may be useful to analyze for soil fertility parameters (pH, Ca, Mg, K, P, organic matter, % N). If soil fertility is low, it may be helpful to apply slow release fertilizers to initiate competitive growth of native vegetation. The Forest may also want to consider monitoring for herbicide concentrations in soils; and soil microbiologic assays; monitoring of plant communities; and monitoring of soil erosion and sedimentation rates.

20. There is always concern about the potential for pesticide contamination of surface and ground water, when pesticides (herbicides) are applied, since some pesticides may be harmful to humans and to fish and wildlife and to sensitive crops at very low concentrations. Also, clean-up of ground water supplies that have been contaminated by persistent pesticides can be very difficult, so it is best to avoid contamination in the first place.

We are also pleased that the risk assessment for soils and ground water evidences a low risk of ground water contamination (page 4-43). The surface water risk analysis shows some potential for water quality risk with picloram treatments (page 4-53), however, we are pleased that it is stated that site-specific reassessments will be done during contract preparation for aerial applications, and if necessary treatment acres would be reduced to minimize water quality effects.

21. Thank you for including the many tables with information on toxicity and hazards associated with herbicide use (e.g., Table 4-4, *Human Hazards Based on Acute Toxicity Categories*, Table 4-5, *Chronic Toxicity Summary*, Table 4-6, *Herbicide Toxicity Hazard Quotients for Workers*, Table 4-13, *Effects of Proposed Herbicides on Aquatic Organisms*, Table 4-19, *Mammalian Toxicity*). We are pleased that the assessment of herbicide drift indicates no significant off-site drift with proposed mitigation measures (page 4-34), and no anticipated significant cumulative health effects.

22. Please be aware that certain pest control activities described in the DEIS may fall under EPA's Worker Protection Standard (WPS) if, (1) the U.S. Forest Service is the "employer" in control of the "operation" and the operation involves or is related to commercial production of timber or timber products, (2) the U.S. Forest Service is using WPS-labeled pesticides, and (3) the pesticide applications in question are related to the production of timber/timber products and they are not covered by one of the applicable exceptions or exemptions. If you have any questions regarding the WPS or its applicability please contact Jaslyn Dobrahner in the Denver EPA office at (303) 312-6252.

23. We are pleased that potential effects to fisheries, amphibians, wildlife and sensitive plants were also evaluated and disclosed in Chapters 3 and 4, with risk evaluation to wildlife on a herbicide-by-herbicide basis. Will Forest biologists and botanists conduct field surveys and identify potential habitats for sensitive and threatened and endangered fish and wildlife and plant species for each treatment area as part of the preparation of the each annual weed management operating plan? We did not see this mitigation measure specifically included in the protection or prevention measures. We suggest that it be included in Appendix C or D.

24. Thank you for discussion and analysis of potential effects on wildlife resources, including threatened and endangered species including Grizzly Bear, Gray Wolf, and Bald Eagle (page 4-60 to 4-81). We note that the final EIS should include the associated FWS Biological Opinion or formal concurrence for the following reasons:

(1) NEPA requires public involvement and full disclosure of all issues upon which a decision is to be made;
(2) The CEQ Regulations for Implementing the Procedural Provisions of NEPA strongly encourage the integration of NEPA requirements with other environmental review and consultation requirements so that all such procedures run concurrently rather than consecutively (40 CFR 1500.2(c) and 1502.25); and
(3) The Endangered Species Act (ESA) consultation process can result in the identification of reasonable and prudent alternatives to preclude jeopardy, and mandated reasonable and prudent measures to reduce incidental take. These can affect project implementation.

Since the Biological Assessment and EIS must evaluate the potential impacts on listed species, they can jointly assist in analyzing the effectiveness of alternatives and

mitigation measures. EPA recommends that the final EIS and Record of Decision not be completed prior to the completion of ESA consultation. If the consultation process is treated as a separate process, the Agencies risk USFWS identification of additional significant impacts, new mitigation measures, or changes to the preferred alternative. If these changes have not been evaluated in the final EIS, a supplement to the EIS would be warranted.

11

4

Glenn Gay
Gay Ranch, Inc.
HC 59 Box 7
Broadus, MT 59317
(406) 427-5457

September 24, 2006

Nancy T. Curriden, Forest Supervisor
Attn. Kim Reid, Project Coordinator
Custer National Forest
1310 Main Street
Billings, MT 59105

RE:Draft Custer National Forest Weed Management EIS

Gay Ranch, Inc. borders the southeast corner of the Ashland Ranger District of Custer National Forest. We also have the Bloom Creek Allotment grazing permit on the Ashland Ranger District. This is the Powder River Breaks area identified for biocontrol treatment.

I support Alternative 1 as discussed in the Draft EIS. The only way to control the relentless invasion of noxious weeds is with a coordinated effort using chemical, biological, and cultural methods. The EIS has a comprehensive discussion of the various methods proposed with a realistic prediction of the outcome. The environmental impacts of the various methods are adequately analyzed.

I have been releasing the various *Aphthona* leafy spurge flea beetles on this ranch and in the Powder River Breaks area since 1990. The last two years, I have not found a leafy spurge infestation in this area that does not have flea beetles. Biocontrol is slow but the beetles are established and will help slow the spread of leafy spurge.

Chemical or cultural control should be used in the areas where the noxious weeds are not established and can be eliminated. Biocontrol is too slow and will allow the noxious weed to become established.

Unfortunately leafy spurge will never be eliminated from the Powder River Breaks area but with the methods discussed in the EIS we should be able to slow the spread and maybe even contain the infestation to this area.

Yours truly,

Glenn Gay

Glenn Gay

5

United States Department of the Interior
BUREAU OF INDIAN AFFAIRS
Rocky Mountain Regional Office
316 North 26th Street
Billings, Montana 59101

In Reply Refer To:
Agriculture & Wildlife Management
Code 462

SEP 21 2006

Kim Reid, Project Coordinator
Custer National Forest
1310 Main Street
Billings, Montana 59105

Dear Ms. Reid:

Enclosed are comments regarding the Custer National Forest Weed Management Draft Environmental Impact Statement (DEIS). Copies of the pages of the DEIS with specific comments are enclosed for your review and use. These comments do not address the merits of the alternatives, but are more directed at the content and presentation of the information.

My name and work address are:

Larry Beneker
Bureau of Indian Affairs
Rocky Mountain Regional Office
316 North 26th Street
Billings, Montana 59101

Thank you for the opportunity to review and comment on the DEIS. If you have any questions, please contact me at (406)247-7935. 7248

Sincerely,

Larry Beneker

Soil Conservationist

Enclosure

United States Department of the Interior
FISH AND WILDLIFE SERVICE

ECOLOGICAL SERVICES
MONTANA FIELD OFFICE
585 Shepard Way
HELENA, MONTANA 59601
PHONE (406) 449-5225, FAX (406) 449-5339

ES-61130 – Billings
M.19 - Custer National Forest
Custer National Forest Weed Management

October 20, 2006

Nancy Curriden, Forest Supervisor
Custer National Forest
1310 Main Street
Billings, MT 59105

Dear Ms. Curriden:

This document transmits the U.S. Fish and Wildlife Service's (Service) concurrence on your determination of effects for listed species in your biological assessment (BA) for the proposed Custer National Forest Weed Management Plan. Your BA was received in the Billings Sub Office on October 3, 2006. This response is provided by the Service under the authority of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531-1543), the Migratory Bird Treaty Act (16 U.S.C. 703-712), and the Bald and Golden Eagle Protection Act (16 U.S.C. 668 et seq.).

The proposed project would occur on lands administered by the U.S. Department of Agriculture, Forest Service within the Custer National Forest. The Forest is located in southeast Montana on approximately 1.2 million acres of land in parts of Sweet Grass, Stillwater, Carbon, Rosebud, Powder River, and Carter Counties in Montana, and Harding County in South Dakota.

The Forest Service has determined that the proposed action will not affect black-footed ferret (*Mustela nigripes*), and bald eagle (*Haliaeetus leucocephalus*). The Forest Service has determined the fuels reduction program may affect, but is not likely to adversely affect the grizzly bear (*Ursus arctos*), and Canada lynx (*Lynx canadensis*). The project is also not likely to jeopardize the continued existence of the non-essential experimental population of the gray wolf (*Canis lupus*).

The Service concurs with your determination of effects of your project on listed species, and formal consultation is not required. The Service bases its concurrence on the implementation of the conservation measures stated in the BA, and the protection measures in the *Custer National Forest Weed Management Environmental Impact Statement – Biological Assessment Appendices* provided as an attachment to the BA.

2

The Custer National Forest proposes annual weed control on about 1,500 net infested acres (approximately 14,000 managed gross acres) of noxious weeds, 60 net acres tall larkspur, and 5 net acres for infrastructure maintenance (i.e., paved road shoulder maintenance). Actual treatment would provide for adaptive management practices while addressing current infestations as follows:

- About 1,415 net infested acres ground herbicide application is proposed (includes 45 acres of in the AB Wilderness Area);
- About 85 net infested acres aerial treatment application is proposed. Currently, there are about 5 net acres of infestation in the Dry Creek area and about 80 net acres of infestation in the Stillwater area. These areas have potential for aerial treatment needs in the near future due to their remote and steep characteristics. These characteristics reduce the ability for effective ground treatment and have a potential to spread to about 7,300 acres of remote and inaccessible areas.
- About 155 acres using biological control is proposed. Herbicide treatment will be used along the perimeter and small patches to contain the weeds. Current targeted areas include 80 Acres Stillwater, 5 Acres Dry Creek, 28 Acres Rock Cr., 20 Acres Ski Run Rd., 2 Acres Pryor Mountain (Beartooth Ranger District), 10 Acres Powder River Breaks (Ashland Ranger District), 10 Acres Long Pines (Sioux Ranger District).
- Less than 5 acres is proposed to be treated by hand-pulling (herbicides may be used to reduce plant density to low levels, then pull isolated plants);
- Less than 5 acres of cultural treatment by seeding is proposed. Herbicides or grazing may be used to reduce plant density, then plant more desirable and competing vegetation; tilling or burning will most likely apply if future populations are more sizable as to make the treatment more cost effective.
- About 60 acres of tall larkspur control using ground herbicide application is proposed.
- Less than 5 acres for infrastructure maintenance or construction. This includes periodic treatment along paved road shoulders. Other examples include helibases, drainage culverts, special use permits such as telephone and electric transmission lines that may have undesirable vegetation growing in or adjacent to them.

Implementation would occur within a 15 year period. Not all acres would be treated every year. Acres treated will depend on available funding and on a priority rating system. Historical funding has allowed for treatment of between 600 and 1,200 acres annually. Most areas would need repeated treatment for 5 to 8 years to ensure effective control. Monitoring would be used to determine effectiveness and to identify areas that would need to be re-treated or if treatment areas could be reduced based on effectiveness of previous treatments.

Under the proposed action alternative new weed infestations could be treated provided that the steps identified in the Adaptive Management section of the BA's appendices are followed. They include criteria to help determine the appropriate treatment for new weed sites. All infestations

3

will use the priority decision process outlined in the BA. If the weeds are in the AB Wilderness, then Wilderness Minimum Tool Guidelines will be used.

All herbicides will be applied according to label specification, or when additional protection measures are required by Forest Service policy as described in the BA. Impacts on soil and water will be mitigated to meet public land water laws, state pesticide application requirements, Northern Region Soil and Water Standards, and Custer Forest Plan Standards.

This concludes informal consultation and conference pursuant to regulations in 50 CFR 402.13 implementing the ESA of 1973, as amended. This project should be re-analyzed if new information reveals effects of the action that may affect threatened, endangered or proposed species, if the project is modified in a manner that causes an effect not considered in this consultation, the proposed action may affect a new species that is listed or critical habitat identified or if timing, spatial restrictions, and protective measures will not be implemented.

The Service appreciates efforts by Custer National Forest to minimize negative impacts to listed species in Montana. We also support your efforts to minimize impacts on sensitive and management indicator species. For further questions, please call Lou Hanebury at the Billings Sub Office at 406-247-7367.

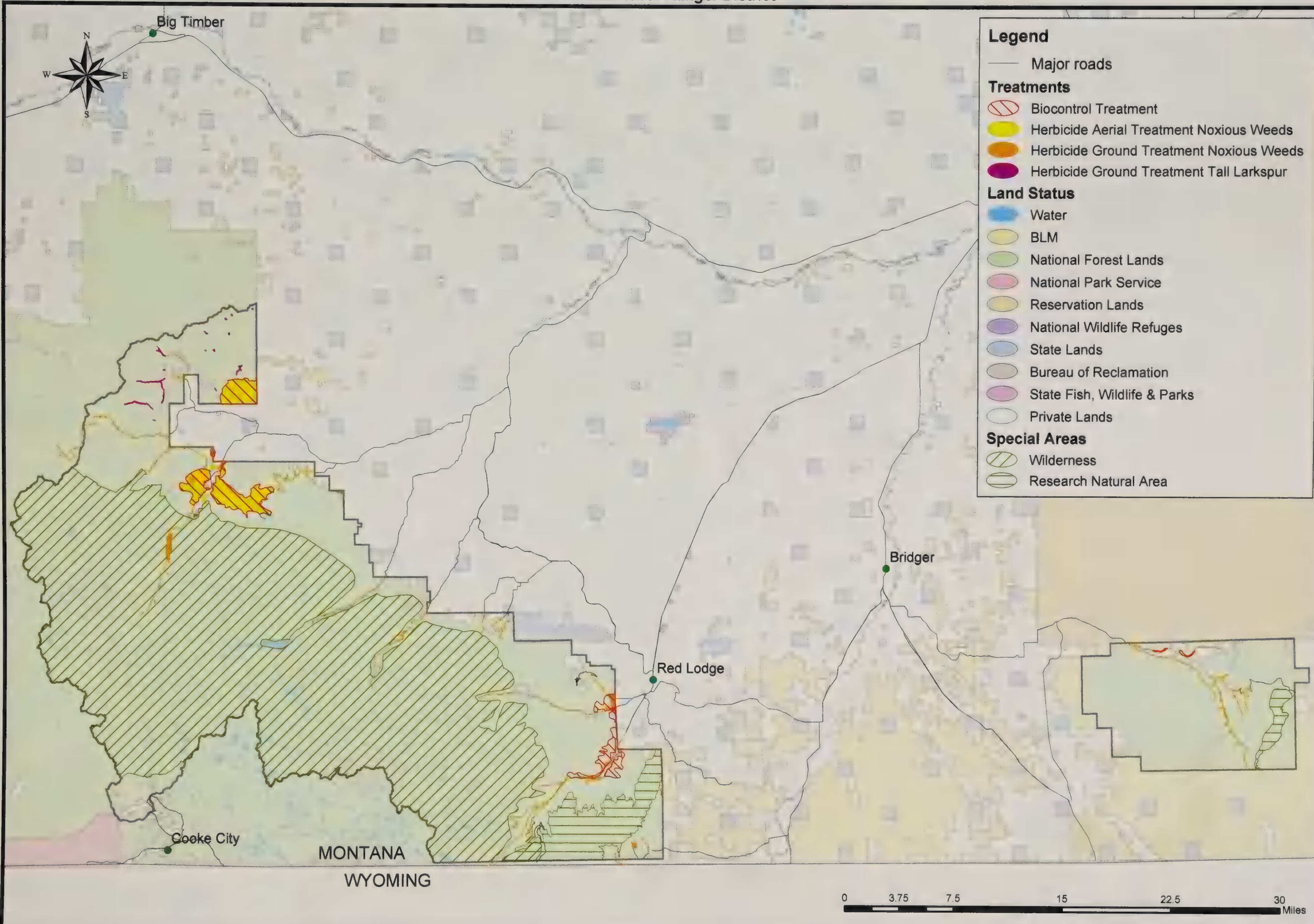
Sincerely,

R. Mark Wilson

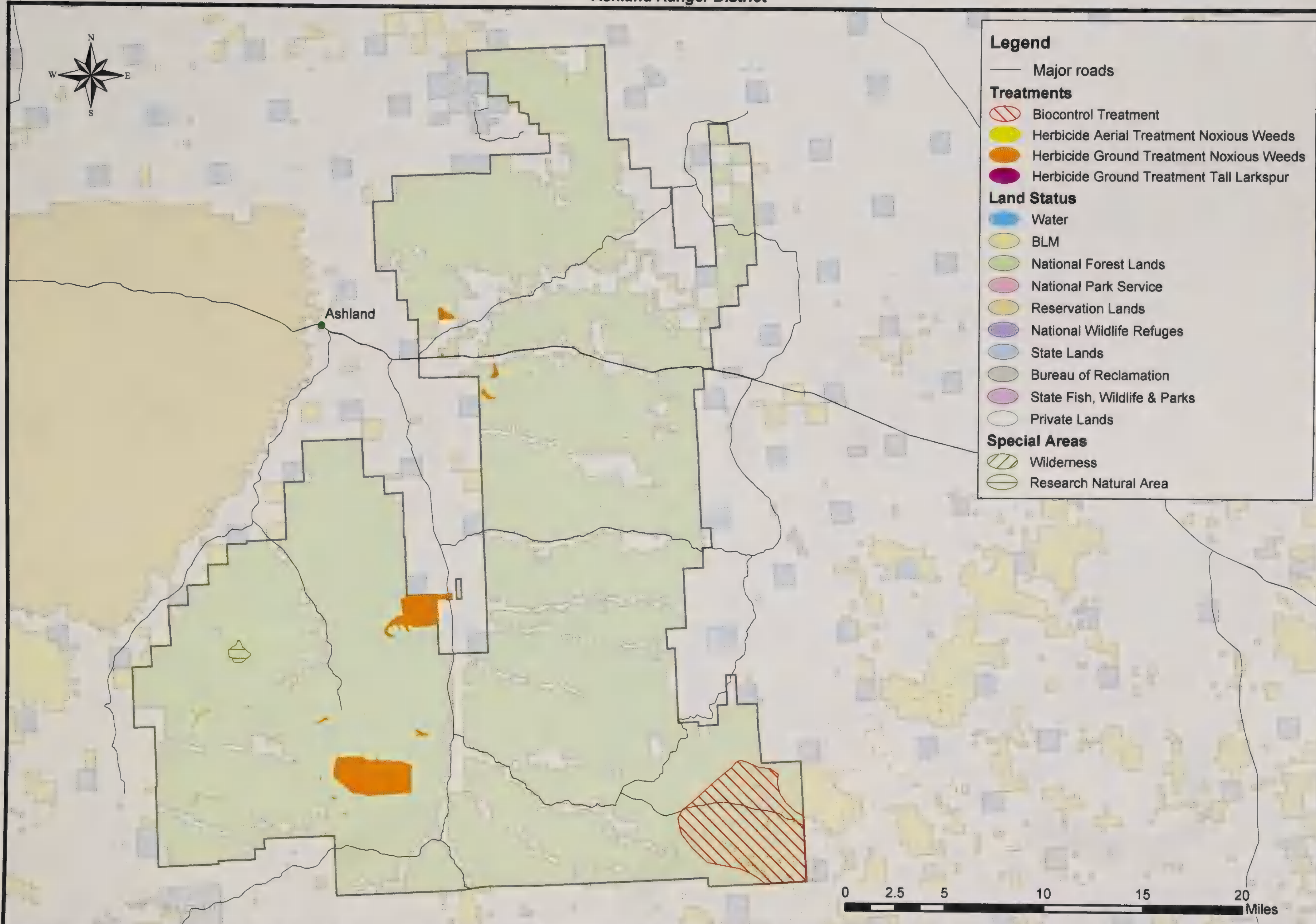
R. Mark Wilson
Field Supervisor

cc: FWS/ES, Billings, MT (Attn: Lou Hanebury)
FWS/ES, Pierre, SD (Attn: Pete Gober)
USFS/Custer National Forest, Billings, MT (Attn: Tom Whitford)

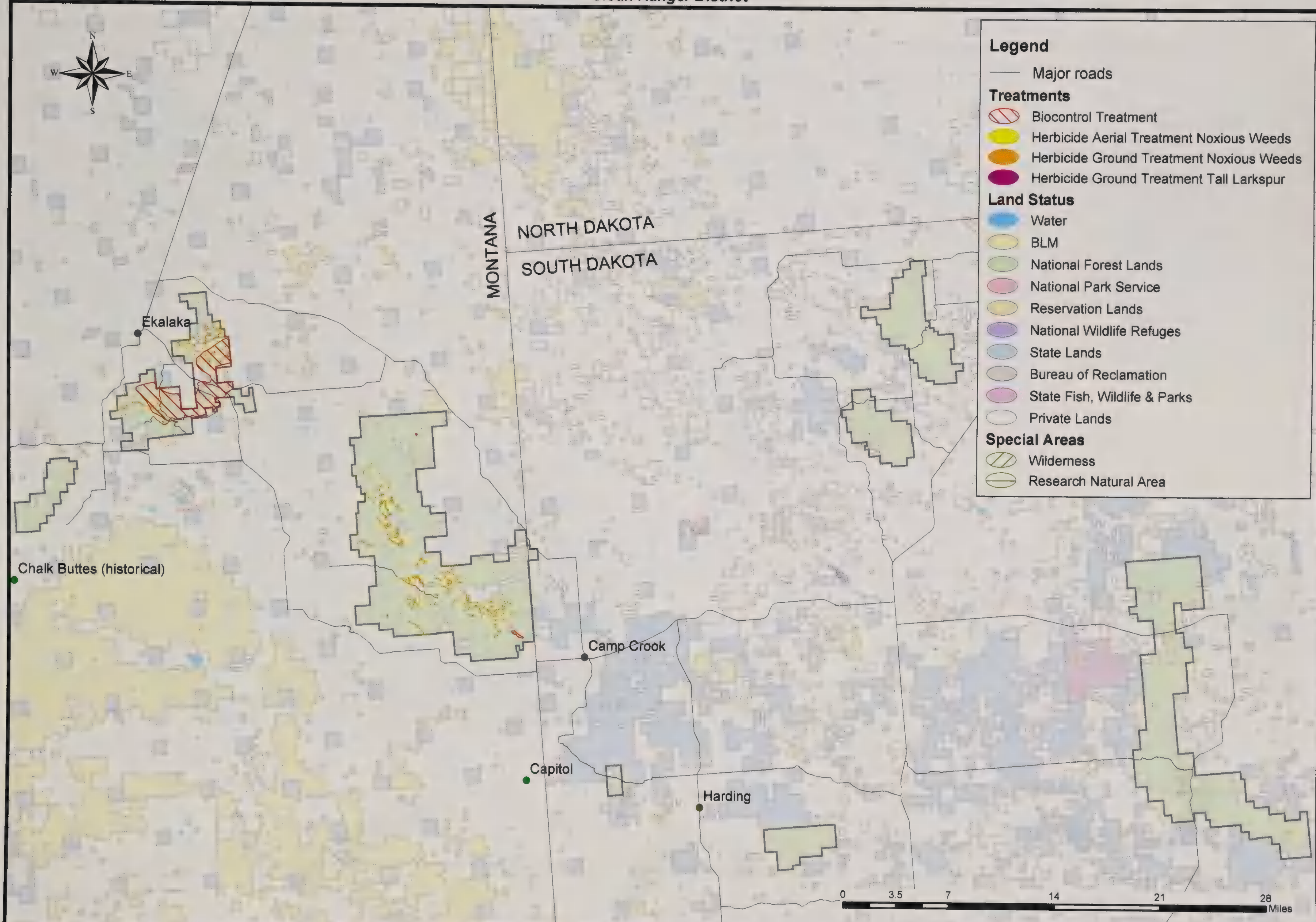
Custer National Forest Weed Management EIS
Alternative 1 Proposed Action - Integrated Pest Management
Beartooth Ranger District



Custer National Forest Weed Management EIS
Alternative 1 Proposed Action - Integrated Pest Management
Ashland Ranger District

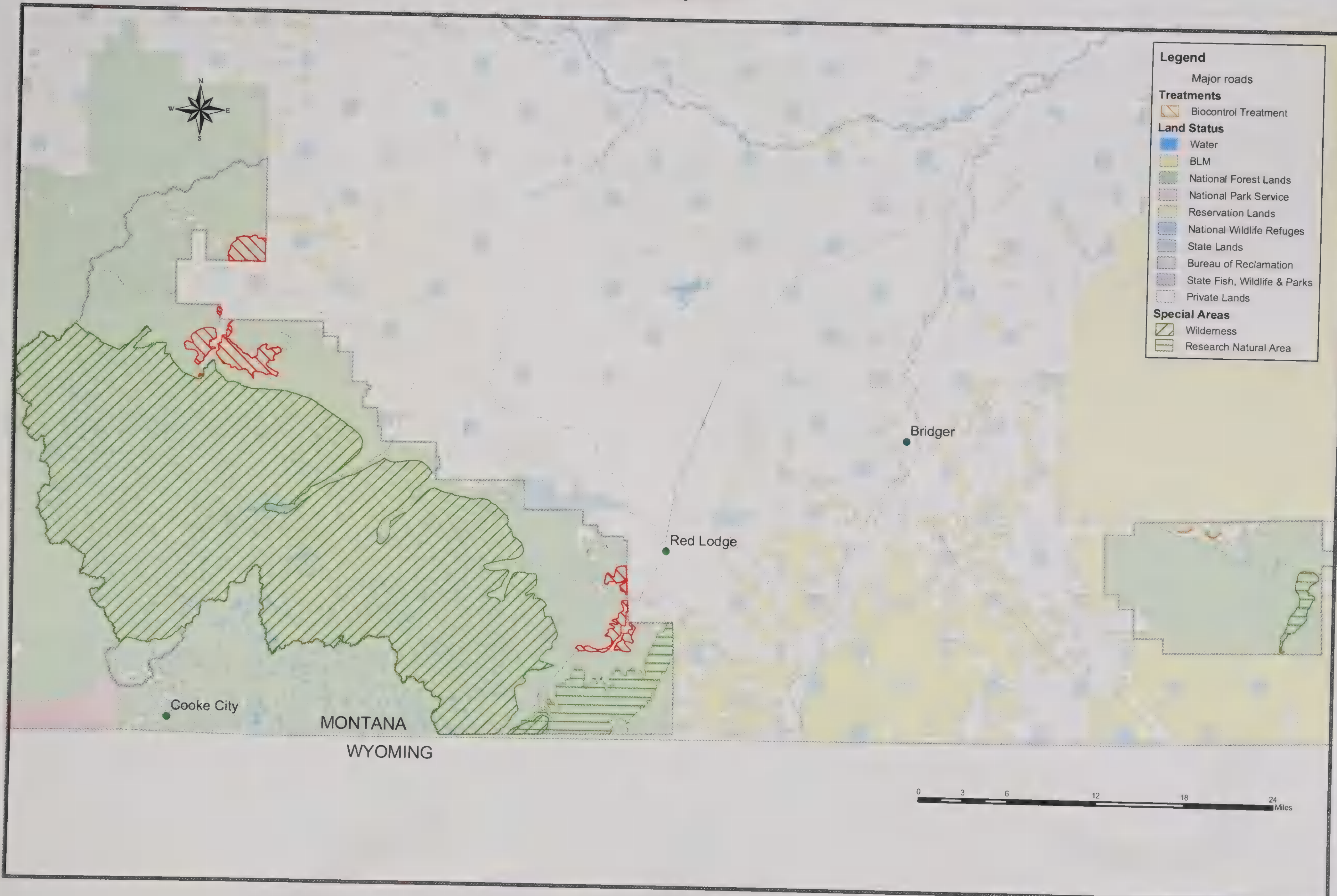


Custer National Forest Weed Management EIS
Alternative 1 Proposed Action - Integrated Pest Management
Sioux Ranger District



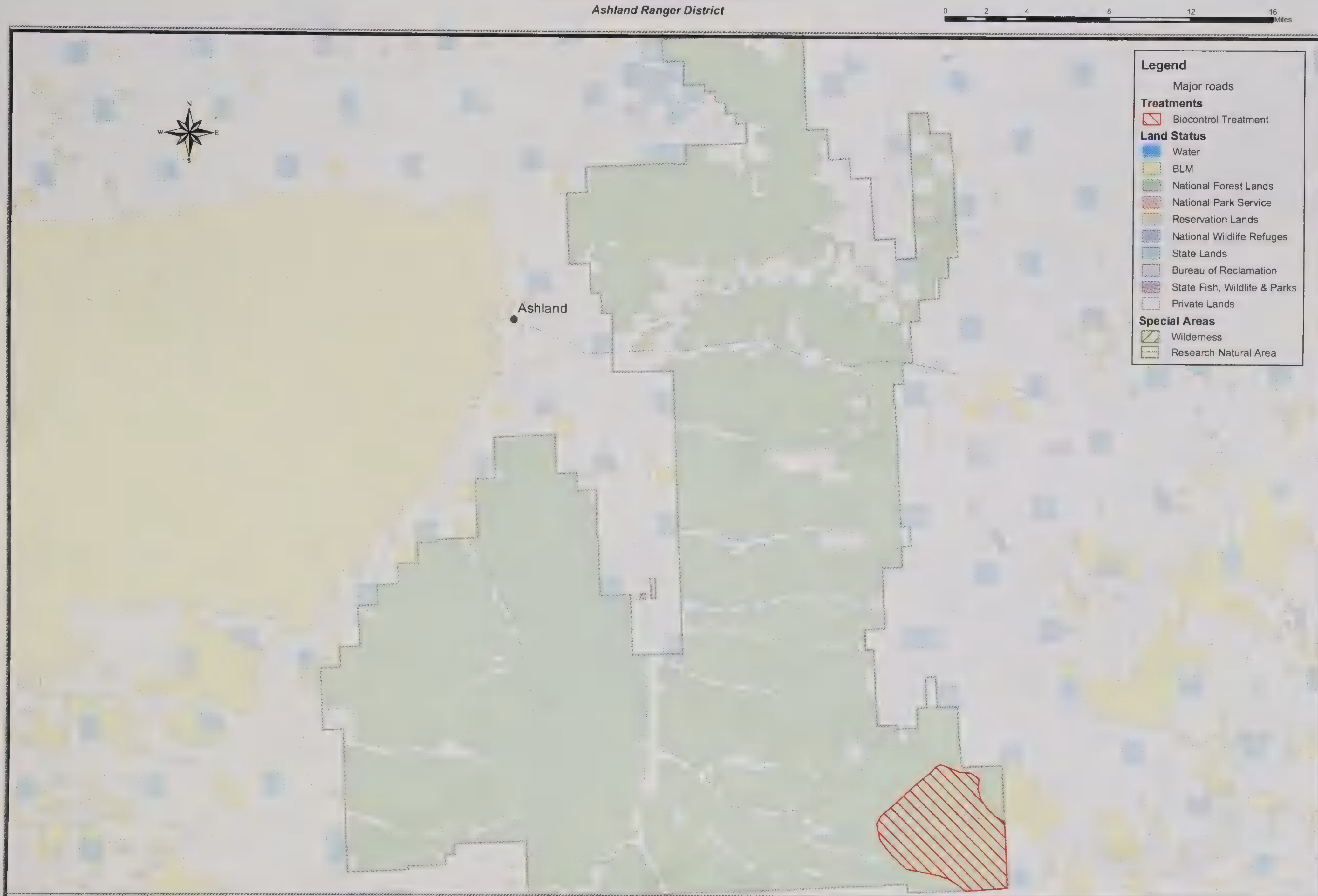
Custer National Forest Weed Management EIS
Alternative 2 - No Herbicide Application

Beartooth Ranger District



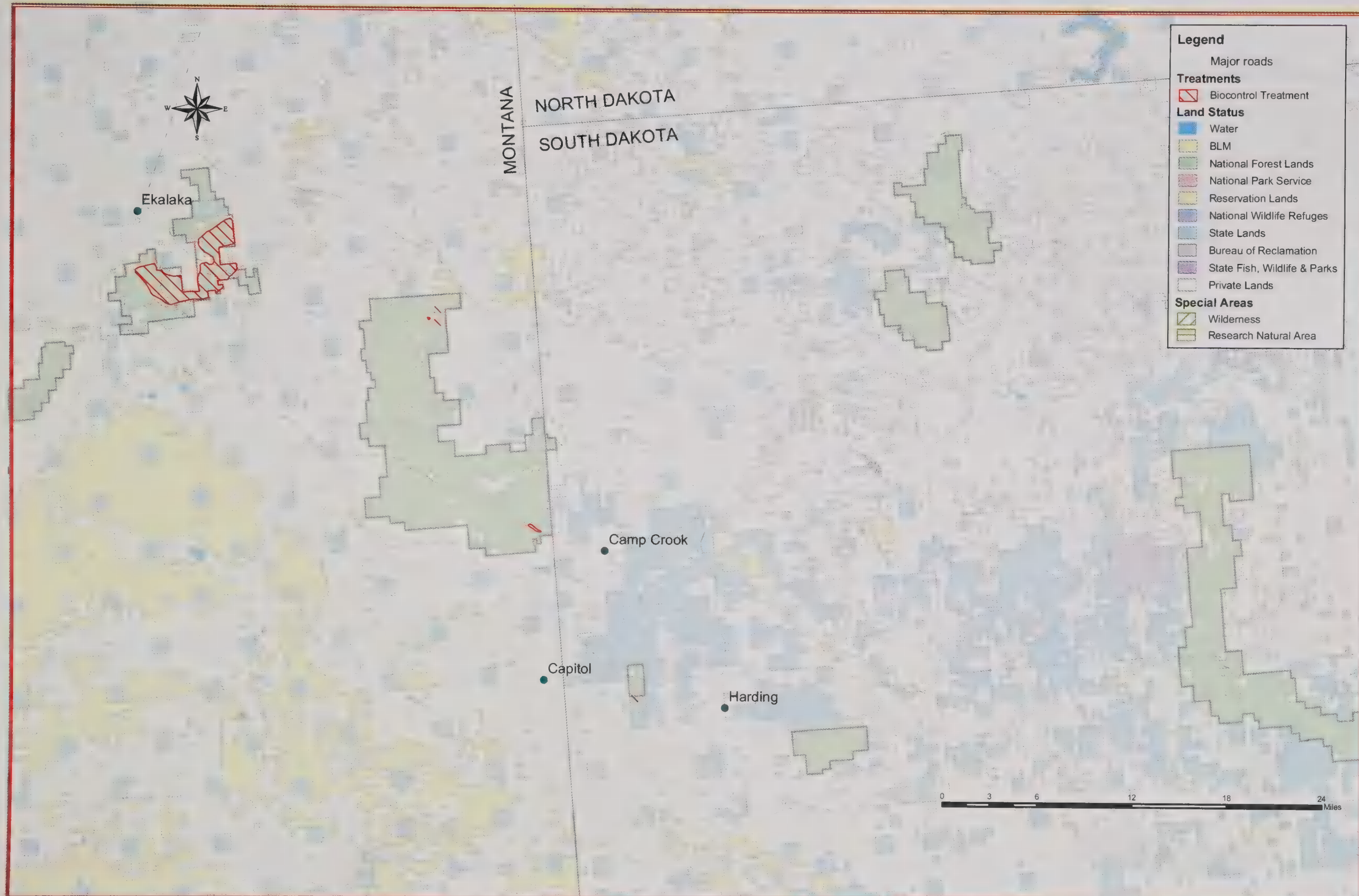
Custer National Forest Weed Management EIS
Alternative 2 - No Herbicide Application

Ashland Ranger District

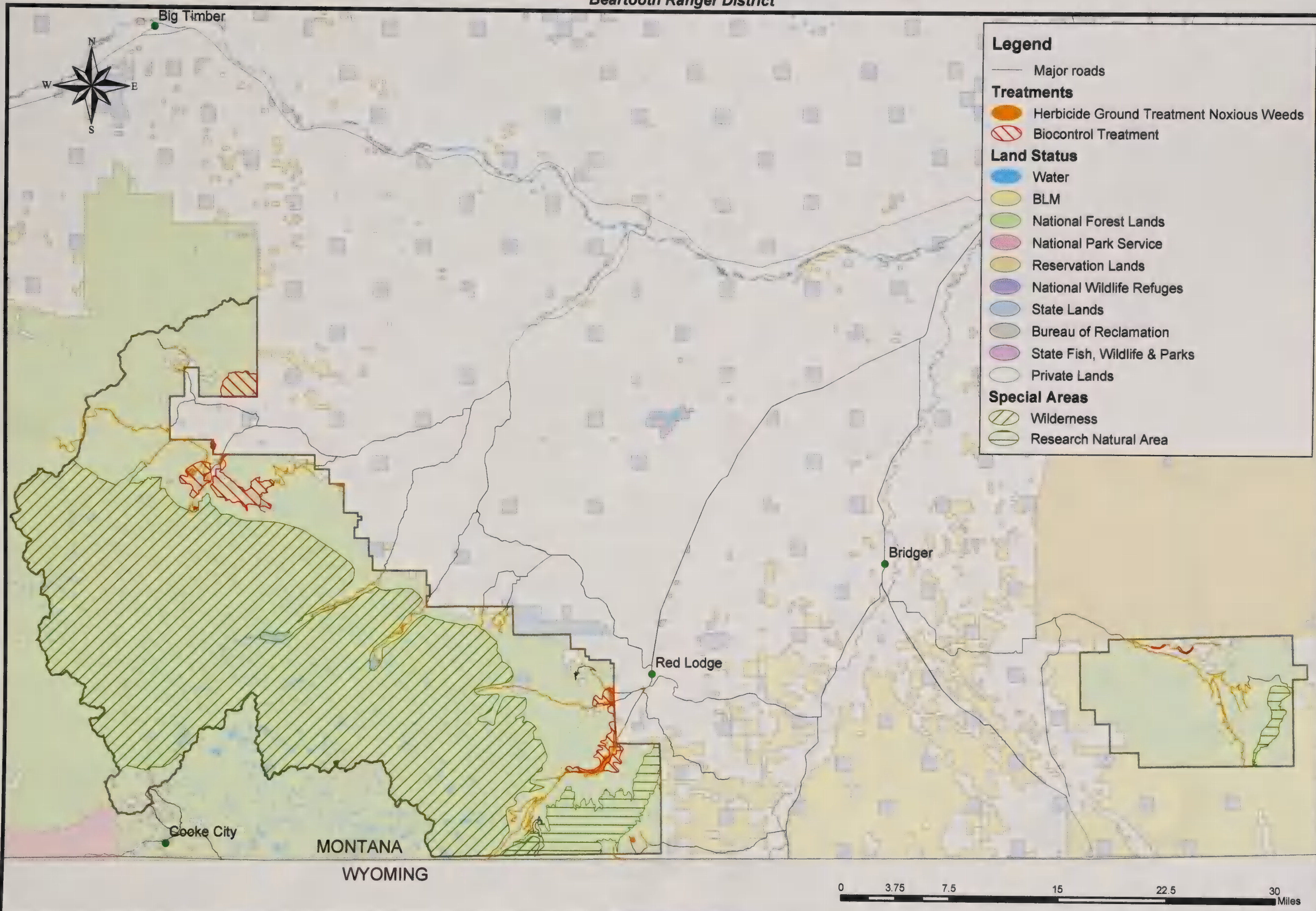


Custer National Forest Weed Management EIS
Alternative 2 - No Herbicide Application

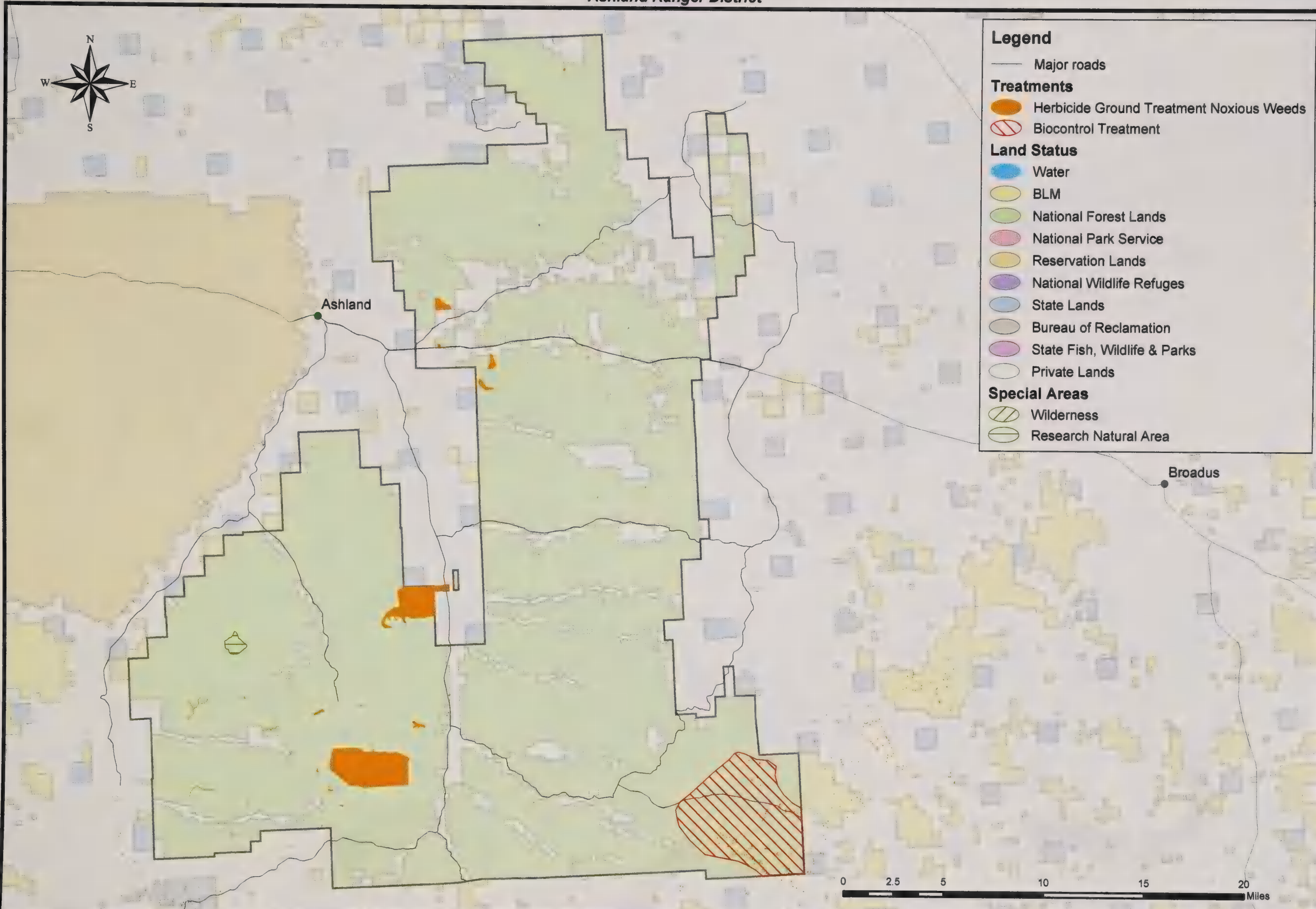
Sioux Ranger District



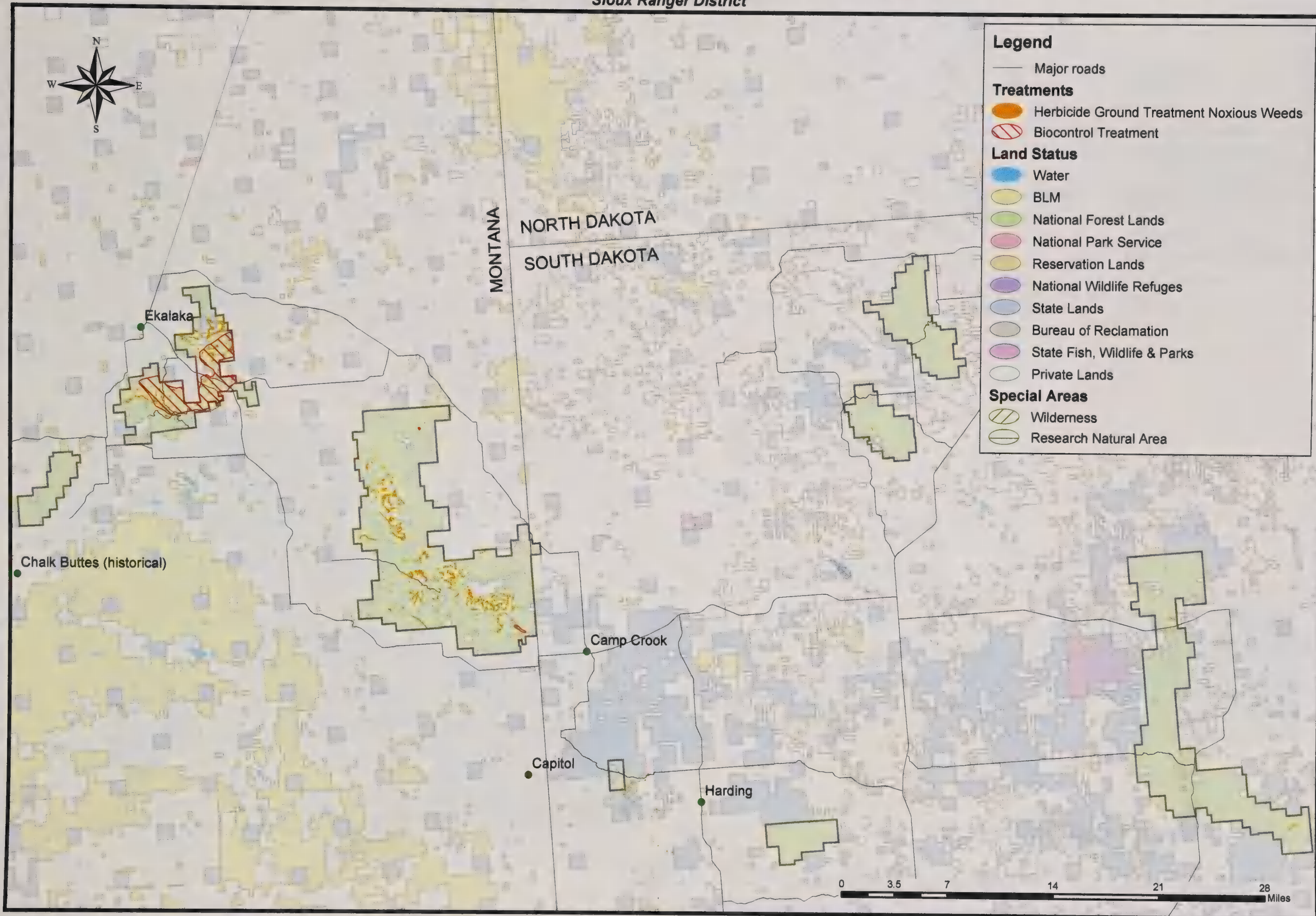
Custer National Forest Weed Management EIS
Alternative 3 No Action - Current Integrated Pest Management
Beartooth Ranger District



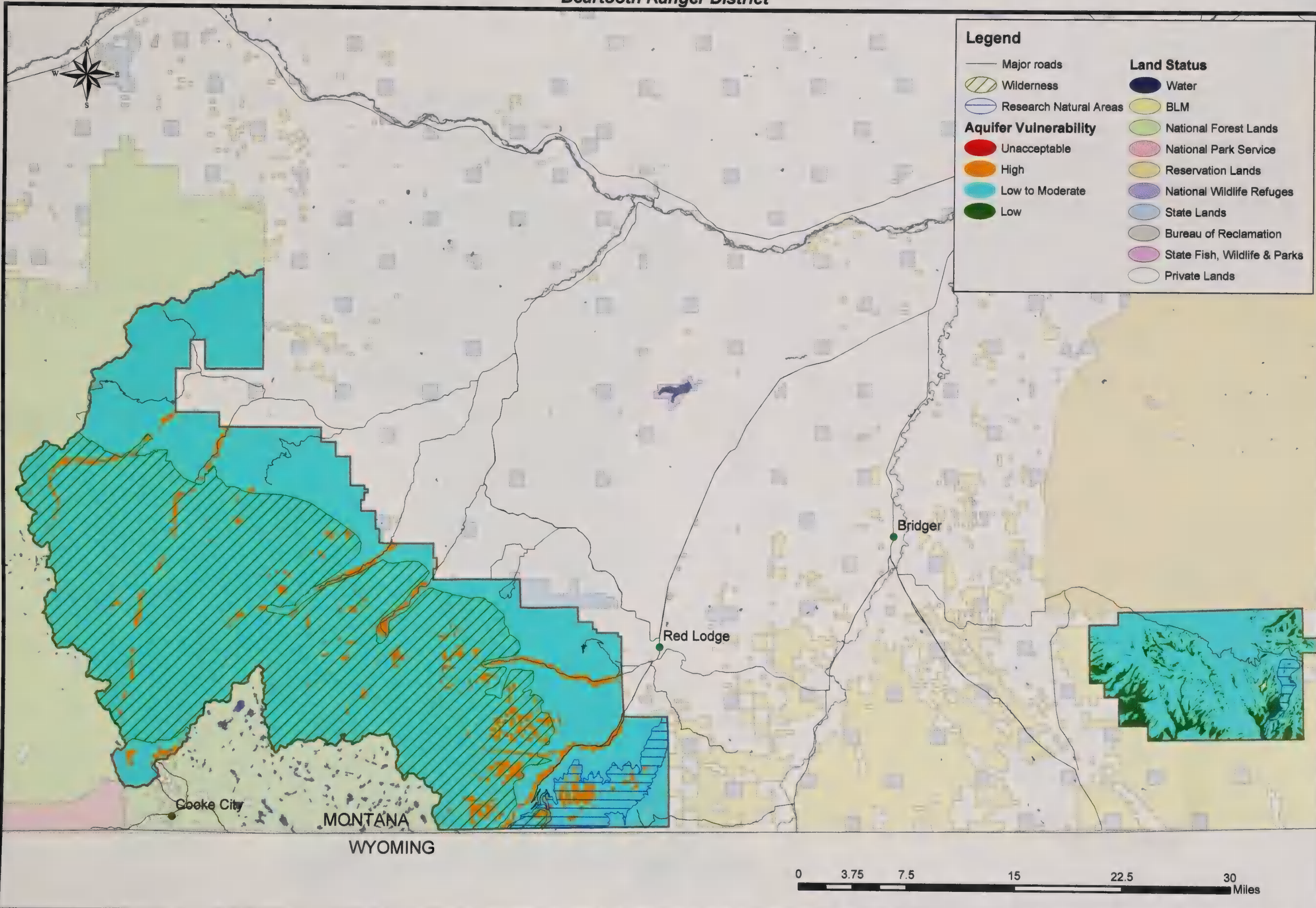
Custer National Forest Weed Management EIS
Alternative 3 No Action - Current Integrated Pest Management
Ashland Ranger District



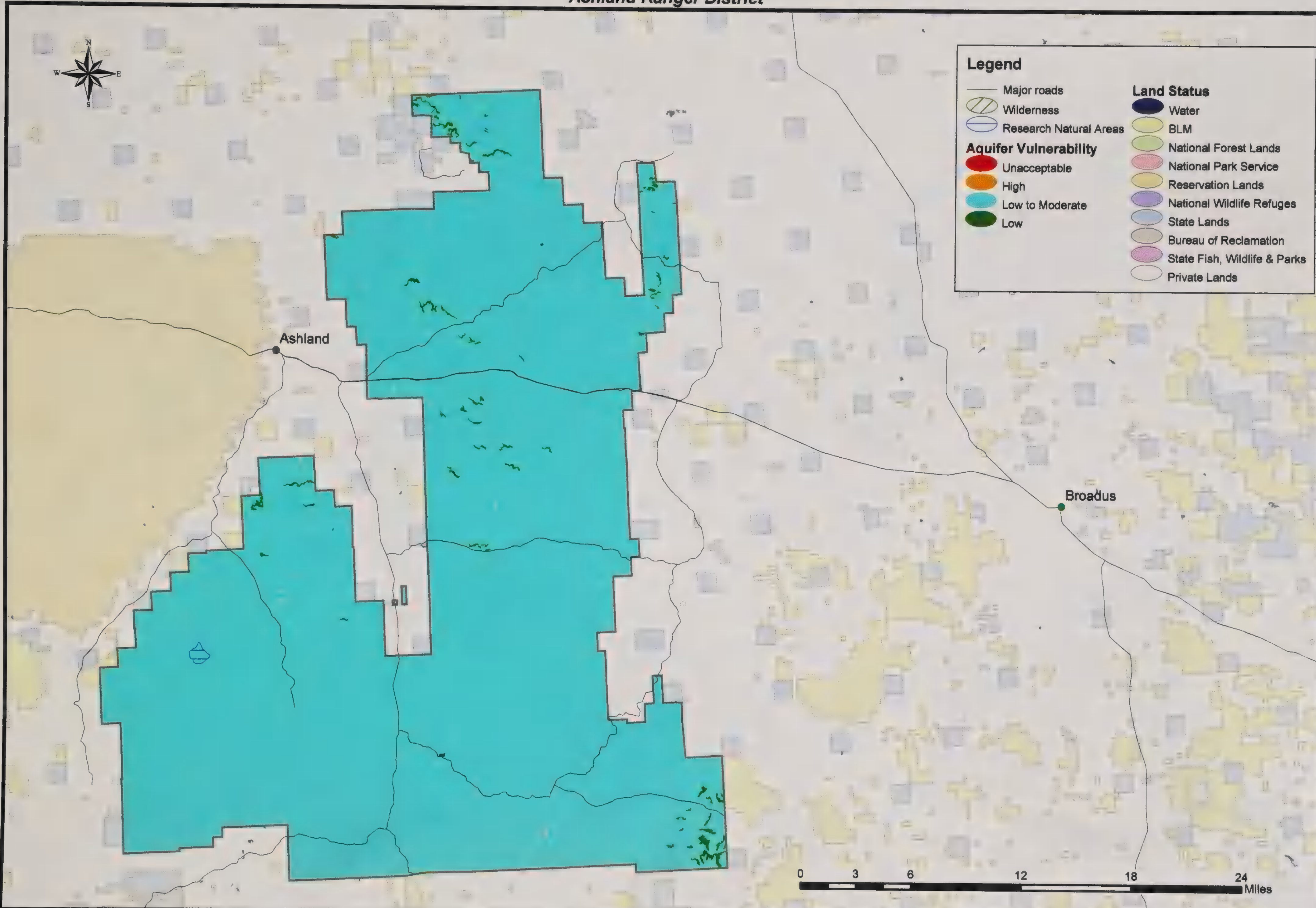
Custer National Forest Weed Management EIS
Alternative 3 No Action - Current Integrated Pest Management
Sioux Ranger District



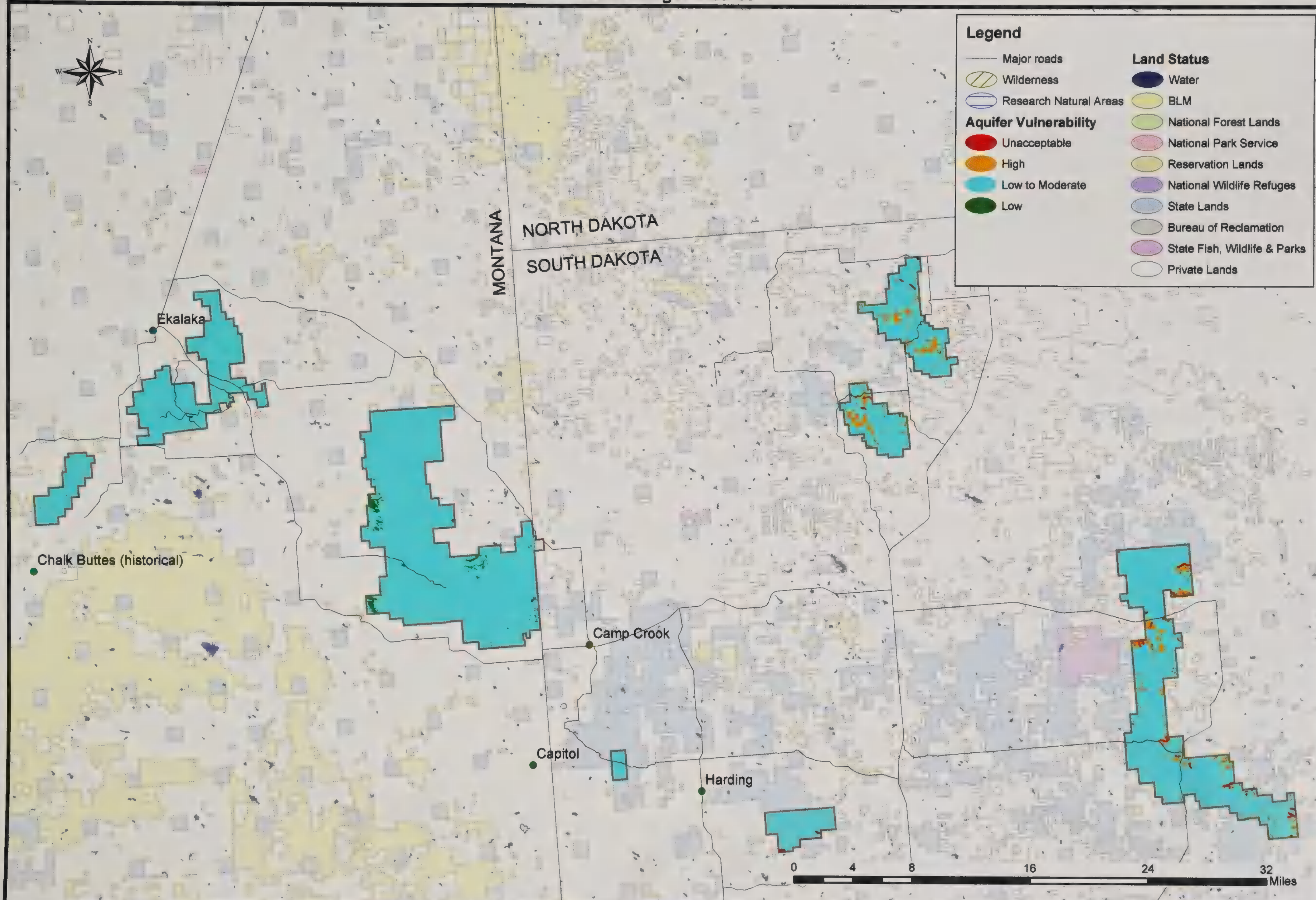
Custer National Forest Weed Management EIS
Relative Aquifer Vulnerability Evaluation for Herbicide Contamination
Beartooth Ranger District



Custer National Forest Weed Management EIS
Relative Aquifer Vulnerability Evaluation for Herbicide Contamination
Ashland Ranger District



Custer National Forest Weed Management EIS
Relative Aquifier Vulnerability Evaluation for Herbicide Contamination
Sioux Ranger District



CUSTER NATIONAL FOREST WEED MANAGEMENT EIS

APPENDICES

APPENDIX A
CUSTER NATIONAL FOREST WEED SPECIES OF CONCERN

Common Name	Scientific Name	MT & County Lists[2] & Category	SD List[3]	WY List[4]	GYCC Category[5]	Occurs on Beartooth RD	Occurs on Ashland RD	Occurs on Sioux RD
State Listed New Invaders								
Common Crupina	*Crupina vulgaris*	S-3			3			
Eurasian Common Milfoil (Spike Watermilfoil)	*Myriophyllum spicatum*	S-3			2			
Russian Skeletonweed (Hogbite)	*Chondrilla juncea*	S-3			3			
Yellow-Starthistle	*Centaurea solstitialis*	S-3			3			
Yellow Flag Iris (Pale Yellow Iris)	*Iris pseudacorus*	S-3						
County Listed Invaders								
Bull Thistle	***Circium vulgare***	**L-Sweet Grass**	**L**			**X**		
Common Burdock (Lesser Burrdock)	*Arctium minus*	L-Stillwater & Sweet Grass	L	S	1			
Common Cocklebur (Rough Cockleburr)	*Xanthium strumarium*	L-Sweet Grass						
Common or Absinth Wormwood (Absinthium)	*Artemisia absinthium*	L-Carbon	L		1			
Common Mullein	***Verbascum thapsus* ****	**L-Stillwater**	**L**		**1**	**X**		**X**
Flowering Rush	*Butomus umballatus*	L-Carbon						
Milk Thistle (Blessed Milk Thistle)	*Silybum marianum*	L-Carbon						
Spiney Plumeless Thistle	*Carduus acanthoides*		L	S				
Poison Hemlock	***Conium maculatum***	**L-Rosebud**			**3**		**X**	
Puncture Vine	*Tribulus terrestris*		L					
Scotch Thistle (Scotch Cottonthistle)	*Onopordum acanthium*	L-Carbon, Rosebud, Sweet Grass	L	S				
White Bryony	*Bryonia alba* **	L-Carbon			3			
Other Invaders (also see Appendix B)								
Blueweed (Common Vipersbugloss)	*Echium vulgare*				3			
Goatsbeard / Meadow Salsify (Jack-Go-To-Bed-At-Noon)	*Tragopogon pratensis*				3			
Creeping Bellflower (Rampion Bellflower)	*Campanula rapunculoides* **				2			
Hairy Whitetop	*Cardaria pubescens*			S				
King-Devil Hawkweed Tall Hawkweed)	*Hieracium piloselloides*				2			
Kochia (Mexican Fireweed)	*Kochia scoparia*				3			
Purple Mustard (Cross Flower)	*Chorispora tenella*				3			
Quackgrass	*Agropyron repens*			S				
Reed Canarygrass	*Phalaris arundinacea* **				1			
Scentless Chamomile (False Mayweed)	*Matricaria maritima*				3			
Sheep Sorrel (Common Sheep Sorrel)	*Rumex acetosella*				1			
Yellow-Devil Hawkweed	*Hieracium floribundum*				2			
Posionous Weeds								
Tall Larkspur (Duncecap Larkspur)	***Delphinium occidentale***	**L-Custer NF**				**X**		

APPENDIX A
CUSTER NATIONAL FOREST WEED SPECIES OF CONCERN

TABLE A – 1. WEED SPECIES OF CONCERN[1] (Those species in **bold** type occur on the Custer National Forest)

Common Name	Scientific Name	MT & County Lists[2] & Category	SD List[3]	WY List[4]	GYCC Category[5]	Occurs on Beartooth RD	Occurs on Ashland RD	Occurs on Sioux RD
State Listed Wide Spread Invaders								
Canada Thistle	***Cirsium arvense***	**S-1**	**S**	**S**	**1**	**X**	**X**	**X**
Common Tansy	***Tanacetum vulgare***	**S-1**	**L**		**1**			
Dalmatian Toadflax	***Linaria dalmatica***	**S-1**	**L**	**S**	**2**	**X**		
Diffuse Knapweed (White Knapweed)	*Centaurea diffusa*	S-1	L	S	3			
Field Bindweed	***Convolvulus arvensis***	**S-1**	**S**	**S**	**2**	**X**		
Houndstongue (Gypsy Flower)	***Cynoglossum officinale***	**S-1**	**L**	**S**	**1**	**X**	**X**	
Leafy Spurge	***Euphorbia esula***	**S-1**	**S**	**S**	**2**	**X**	**X**	**X**
Ox-eye Daisy	***Chrysanthemum leucanthemum***	**S-1**		**S**	**1**	**X**		
Perennial Sowthistle (Field Sowthistle)	*Sonchus arvensis*	L-Carbon	S	S	2			
Russian Knapweed (Hardheads)	***Acroptilon repens (Centaurea repens)***	**S-1**	**S**	**S**	**3**			**X**
Spotted Knapweed	***Centaurea maculosa***	**S-1**	**S, L**	**S**	**1**	**X**	**X**	**X**
Common St. Johnswort	*Hypericum perforatum*	S-1	L		1			
Sulfur Cinquefoil	***Potentilla recta***	**S-1**			**1**	**X**		
Whitetop	*Lepidium draba*	S-1	S	S	2			
Yellow Toadflax (Butter and Eggs)	***Linaria vulgaris***	**S-1**	**L**	**S**	**1**	**X**		
State Listed Rapidly Spreading Invaders								
Dyer's Woad	*Isatis tinctoria*	S-2		S	3			
Meadow Hawkweed	***Hieracium pratense***	**S-2**			**2**	**X**		
Orange Hawkweed	***Hieracium aurantiacum***	**S-2**			1	**X**		
Perennial Pepperweed (Broadleaved Pepperweed)	*Lepidium latifolium*	S-2		S	3			
Purple Loosestrife	*Lythrum salicaria*	S-2	S	S	3			
Salt Cedar (Tamarisk)	***Tamarix spp.***	**S-2**		**S**			**X**	
Tall Buttercup	*Ranunculus acris*	S-2			2			
Tansy Ragwort (Stinking Willie)	*Senecio jacobaea*	S-2			2			

[1] Species of Concern are currently identified state and county listed noxious weeds, and other undesirable weed species.
[2] From Montana Dept. of Ag, 6/27/2003 State Weed List and Montana Dept. of Ag, 2003 (http://agr.state.mt.us/weedpest/noxiousweedslist2.asp), Carbon, Stillwater, Sweet Grass, and Rosebud County lists (http://www.umt.edu/mnps/countyweedlist.pdf)

Montana Noxious Weed List Categories (South Dakota Weed List is not categorized like Montana Weed List, but are grouped in the above Table under a related category):

- 1 = Category 1 noxious weeds are weeds that are currently established and generally widespread in many counties of the state. Management criteria include awareness and education, containment, and suppression of existing infestations and prevention of new infestations. These weeds are capable of rapid spread and render land unfit or greatly limit beneficial uses.
- 2 = Category 2 noxious weeds have recently been introduced into the state or are rapidly spreading from their current infestation sites. These weeds are capable of rapid spread and invasion of lands, rendering lands unfit for beneficial uses. Management criteria include awareness and education, monitoring and containment of known infestations and eradication where possible.
- 3 = Category 3 noxious weeds have not been detected in the state or may be found only in small, scattered, localized infestations. Management criteria include awareness and education, early detection and immediate action to eradicate infestations. These weeds are known pests in nearby states and are capable of rapid spread and render land unfit for beneficial uses.
- S = State listed species
- L = Locally listed species by County.

[3] South Dakota Dept. of Ag, 2004. (http://www.state.sd.us/doa/das/noxious.htm#weed)
[4] Rice, 2003.
[5] USDA, 2002.

GYCC Priority key by Category: Categories developed for the Greater Yellowstone Area by the Greater Yellowstone Coordinating Committee
1 = 3rd Priority; Widespread Invaders; goal is containment within infested areas and reduction of plant populations;
2 = 2nd Priority; New Invaders; goal is containment within already infested areas and strong emphasis on reduction of populations;
3 = 1st Priority; Potential Invaders; Currently absent from Custer NF; goal is prevention; however, if these species are found on the Custer NF, they would be considered for treatment with herbicides with the goal of eradication.

APPENDIX B
INVASIVE SPECIES IN OR NEAR THE CUSTER NF

This Appendix outlines invasive species by District area (Table B – 1) and within the Greater Yellowstone Area (Table B – 2).

TABLE B – 1. INVASIVE SPECIES BY DISTRICT[1]

Invasive Species in or near the Custer National Forest				Beartooth Area						Ashland Area				Sioux Area		
Genus	Species	Common Name	Noxious In	Carbon, MT	Stillwater, MT	Sweet Grass, MT	Park, MT	Park, WY	Bighorn, WY	Bighorn, MT	Sheridan, WY	Powder River, MT	Rosebud, MT	Crook, WY	Carter, MT	Harding, SD
NOXIOUS IN MONTANA OR SOUTH DAKOTA																
Acroptilon	*repens*	Russian knapweed	ID,**MT**,OR,WA,WY, **SD**	X	X	X	X	X	X	X	X	X	X	X	X	X
Centaurea	*diffusa*	diffuse knapweed	ID, **MT**, OR, WA,WY		X	X			X	X		X				
Centaurea	*maculosa*	spotted knapweed	ID,**MT**,OR,WA,WY	X	X	X	X	X	X	X	X	X	X	X	X	
Centaurea	*solstitialis*	yellow starthistle	ID,**MT**,OR,WA	X		X										
Chondrilla	*juncea*	rush skeletonweed	ID,**MT**,OR,WA													
Chrysanthemum	*leucanthemum*	oxeye daisy	**MT**,WA,WY	X	X	X	X	X			X			X		
Cirsium	*arvense*	Canada thistle	ID,**MT**,OR,WA,WY, **SD**	X	X	X	X	X	X	X	X	X	X	X	X	X
Convolvulus	*arvensis*	field bindweed	ID,**MT**,OR,WA,WY, **SD**	X	X	X	X	X	X	X	X	X	X	X	X	X
Cynoglossum	*officinale*	houndstongue	**MT**,OR, WA, WY	X	X	X	X	X	X	X	X		X	X	X	
Euphorbia	*esula*	leafy spurge	ID,**MT**, OR, WA, WY, **SD**	X	X	X	X	X	X	X	X	X	X	X	X	X
Hieracium	*aurantiacum*	orange hawkweed	ID,**MT**, WA													
Hieracium	*floribundum*	yellow-devil hawkweed	**MT**, WA													
Hieracium	*piloselloides*	kingdevil hawkweed	**MT**													
Hieracium	*pratense*	meadow hawkweed	ID,**MT**, WA													
Hypericum	*perforatum*	St. Johnswort	**MT**, OR, WA		X	X	X			X		X		X		
Isatis	*tinctoria*	dyer's woad	ID,**MT**,OR,WA,WY			X	X									
Lepidium	*draba*	hoary cress	ID,**MT**,OR,WA,WY, **SD**	X	X	X	X	X	X	X	X	X	X	X	X	X
Linaria	*dalmatica*	dalmatian toadflax	ID, **MT**, OR, WA, WY	X	X	X	X	X			X		X	X		
Lythrum	*salicaria*	purple loosestrife	ID,**MT**,OR,WA,WY, **SD**					X	X		X		X			X
Lythrum	*virgatum*	wandlike loosestrife	**MT**, WA													
Potentilla	*recta*	sulfur cinquefoil	**MT**, OR, WA	X	X	X	X	X		X	X		X	X		
Ranunculus	*acris*	tall buttercup	**MT**	X	X			X								
Senecio	*jacobaea*	tansy ragwort	ID,**MT**,OR,WA													
Sonchus	*arvensis*	perennial sowthistle	ID,WA,WY, **SD**				X	X	X			X	X			X
Tamarix	*spp.*	Tamarix complex (combined)	**MT**, WY	X		X		X	X	X	X	X	X			
Tanacetum	*vulgare*	common tansy	**MT**, WA				X				X	X	X			
NOXIOUS IN OTHER STATES, BUT OCCURING IN MONTANA OR SOUTH DAKOTA																
Abutilon	*theophrasti*	velvetleaf	OR,WA	X	X					X						
Aegilops	*cylindrica*	jointed goatgrass	ID,OR,WA	X	X					X		X				
Agropyron	*repens*	quackgrass	OR,WY	X	X		X	X		X		X	X		X	
Anchusa	*arvensis*	small bugloss	WA										X			
Anchusa	*officinalis*	common bugloss	WA		X											
Arctium	*minus*	common burdock	WY		X		X	X	X	X	X			X	X	
Artemisia	*absinthium*	absinth wormwood	WA	X						X	X					X

[1] University of Montana Invaders Database System (http://invader.dbs.umt.edu/)

APPENDIX B
INVASIVE SPECIES IN OR NEAR THE CUSTER NF

Invasive Species in or near the Custer National Forest				Beartooth Area						Ashland Area				Sioux Area		
Genus	Species	Common Name	Noxious In	Carbon, MT	Stillwater, MT	Sweet Grass, MT	Park, MT	Park, WY	Bighorn, WY	Bighorn, MT	Sheridan, WY	Powder River, MT	Rosebud, MT	Crook, WY	Carter, MT	Harding, SD
Bryonia	*alba*	white bryony	WA		X	X	X			X						
Carduus	*acanthoides*	plumeless thistle	WA,WY			X								X		
Carduus	*nutans*	musk thistle	ID,OR,WA,WY			X	X	X	X		X		X	X		
Cirsium	*vulgare*	bull thistle	OR,WA		X		X	X	X		X			X	X	
Conium	*maculatum*	poison hemlock	ID,OR,WA	X	X		X			X		X	X			
Cuscuta	*approximata*	clustered dodder	OR,WA							X	X				X	
Daucus	*carota*	wild carrot	WA			X				X						
Gypsophila	*paniculata*	baby's breath	WA	X												
Halogeton	*glomeratus*	halogeton	OR	X				X	X							
Hyoscyamus	*niger*	black henbane	ID,WA	X	X	X	X	X	X	X	X	X				
Impatiens	*glandulifera*	Himalayan balsam	WA				X									
Kochia	*scoparia*	kochia	OR,WA	X		X	X			X		X	X			
Lepidium	*latifolium*	perennial pepperweed	ID,OR,WA,WY				X		X	X				X		
Lepidium	*pubescens*	hairy whitetop	WA,WY	X			X	X	X	X						
Linaria	*vulgaris*	yellow toadflax	ID,OR,WA,WY	X			X	X	X	X		X		X		
Matricaria	*maritima*	scentless chamomile	WA									X				
Onopordum	*acanthium*	Scotch thistle	ID,OR,WA,WY	X				X			X			X		
Phalaris	*arundinacea*	reed canarygrass	WA	X	X		X	X		X			X	X	X	
Polygonum	*sachalinense*	giant knotweed	OR,WA	X	X	X	X									
Rorippa	*austriaca*	Austrian fieldcress	WA	X			X									
Rorippa	*sylvestris*	yellow fieldcress	OR												X	
Secale	*cereale*	cultivated rye	WA		X											
Sorghum	*halepense*	Johnsongrass	ID,OR,WA	X												
Tribulus	*terrestris*	puncturevine	ID,OR,WA	X			X	X	X	X			X	X	X	
Xanthium	*spinosum*	spiny cocklebur	OR,WA				X									
OTHER INVASIVE SPECIES IN OR NEAR THE CUSTER NATIONAL FOREST																
Agropyron	*cristatum*	crested wheatgrass		X			X	X		X		X	X			
Agropyron	*elongatum*	tall wheatgrass						X						X		
Agropyron	*intermedium*	intermediate wheatgrass			X					X	X	X	X			
Agropyron	*triticeum*	annual wheatgrass				X	X						X			
Agrostemma	*githago*	corn cockle			X	X										
Agrostis	*stolonifera*	creeping bentgrass		X	X	X	X	X	X		X		X	X	X	
Agrostis	*tenuis*	colonial bentgrass											X			
Alopecurus	*arundinaceus*	creeping foxtail		X				X								
Alopecurus	*pratensis*	meadow foxtail		X		X				X						
Althaea	*rosea*	hollyhock												X		
Alyssum	*alyssoides*	yellow alyssum		X	X	X	X		X	X	X	X	X	X		
Alyssum	*desertorum*	dwarf alyssum		X	X	X	X			X	X	X				
Alyssum	*sp.*	madwort					X									
Anthemis	*arvensis*	corn chamomile						X								
Anthemis	*cotula*	mayweed chamomile					X									
Arabis	*glabra*	tower mustard		X	X	X	X	X		X				X	X	
Arctium	*lappa*	great burdock					X									

APPENDIX B
INVASIVE SPECIES IN OR NEAR THE CUSTER NF

Invasive Species in or near the Custer National Forest				Beartooth Area						Ashland Area				Sioux Area		
Genus	Species	Common Name	Noxious In	Carbon, MT	Stillwater, MT	Sweet Grass, MT	Park, MT	Park, WY	Bighorn, WY	Bighorn, MT	Sheridan, WY	Powder River, MT	Rosebud, MT	Crook, WY	Carter, MT	Harding, SD
Arctium	*sp.*	burdock		X												
Arenaria	*serpyllifolia*	thymeleaf sandwort								X	X					
Armoracia	*rusticana*	horseradish			X											
Arrhenatherum	*elatius*	tall oatgrass					X									
Artemisia	*annua*	annual wormwood												X		
Artemisia	*vulgaris*	mugwort								X						
Asparagus	*officinalis*	asparagus			X						X					
Asperugo	*procumbens*	catchweed		X	X	X	X				X	X	X		X	
Astragalus	*cicer*	chick pea milk vetch		X	X											
Atriplex	*heterosperma*	weedy orache		X	X				X							
Atriplex	*hortensis*	garden orach		X			X	X								
Atriplex	*rosea*	red orach				X	X									
Avena	*fatua*	wild oat		X				X	X		X			X		
Avena	*sativa*	common oats							X							
Barbarea	*vulgaris*	yellow rocket		X		X	X							X		
Bassia	*hyssopifolia*	fivehook bassia			X											
Berberis	*vulgaris*	European barberry		X			X									
Berteroa	*incana*	hoary alyssum		X	X	X	X									
Brassica	*hirta*	white mustard					X									
Brassica	*juncea*	Indian mustard												X		
Brassica	*kaber*	wild mustard				X	X					X				
Brassica	*nigra*	black mustard								X						
Bromus	*brizaeformis*	rattlesnake brome					X	X			X					
Bromus	*commutatus*	hairy chess				X	X	X		X	X			X		
Bromus	*japonicus*	Japanese brome		X	X		X			X	X	X	X	X	X	
Bromus	*mollis*	soft brome				X									X	
Bromus	*secalinus*	cheat			X					X				X		
Bromus	*squarrosus*	large flowered brome											X			
Bromus	*tectorum*	downy brome		X	X	X	X	X	X	X	X	X	X	X	X	
Calystegia	*sepium*	hedge bindweed			X					X					X	
Camelina	*microcarpa*	smallseed false flax		X	X		X			X	X	X	X	X	X	
Camelina	*sativa*	largeseed falseflax			X		X			X	X	X				
Campanula	*glomerata*	clustered bellflower			X	X	X			X						
Campanula	*rapunculoides*	creeping bellflower		X	X	X	X					X	X			
Cannabis	*sativa*	marijuana											X			
Capsella	*bursa-pastoris*	shepherd's purse		X	X	X	X	X		X	X		X	X	X	
Caragana	*arborescens*	caragana														
Cardaria	*chalapensis*	chalapa hoarycress		X			X	X					X			
Carthamus	*tinctorius*	safflower														
Carum	*carvi*	common caraway		X		X	X	X								
Cerastium	*vulgatum*	mouseear chickweed		X	X	X	X	X		X					X	
Chenopodium	*album*	common lambsquarters		X	X		X			X			X			
Chenopodium	*botrys*	Jerusalem oak goosefoot				X										
Chenopodium	*glaucum*	oakleaf goosefoot					X									

APPENDIX B
INVASIVE SPECIES IN OR NEAR THE CUSTER NF

Invasive Species in or near the Custer National Forest				Beartooth Area						Ashland Area				Sioux Area		
Genus	Species	Common Name	Noxious In	Carbon, MT	Stillwater, MT	Sweet Grass, MT	Park, MT	Park, WY	Bighorn, WY	Bighorn, MT	Sheridan, WY	Powder River, MT	Rosebud, MT	Crook, WY	Carter, MT	Harding, SD
Chorispora	*tenella*	blue mustard		X	X		X			X		X	X	X		
Chrysanthemum	*parthenium*	feverfew					X									
Cichorium	*intybus*	chicory		X	X						X	X		X		
Conringia	*orientalis*	hare's ear mustard			X		X			X		X	X			
Corispermum	*hyssopifolium*	hyssopleaf tickseed							X	X						
Coronilla	*varia*	trailing crownvetch				X										
Cuscuta	*epithymum*	clover dodder					X						X			
Cynara	*cardunculus*	cardoon					X									
Cynodon	*dactylon*	bermudagrass											X			
Dactylis	*glomerata*	orchardgrass		X		X	X	X		X			X	X	X	
Descurainia	*sophia*	flixweed		X		X	X			X	X	X				
Dianthus	*armeria*	deptford pink			X											
Digitaria	*ischaemum*	smooth crabgrass			X								X			
Digitaria	*sanguinalis*	large crabgrass			X						X					
Dipsacus	*fullonum*	common teasel		X			X									
Dracocephalum	*thymiflorum*	thyme leaved dragonhead												X		
Echinochloa	*colona*	jungle rice													X	
Echinochloa	*crusgalli*	large barnyard grass		X		X	X		X	X	X	X	X	X	X	
Elaeagnus	*angustifolia*	Russian olive		X	X					X	X					
Elymus	*junceus*	Russian wildrye			X											
Eragrostis	*cilianensis*	stinkgrass		X		X							X	X	X	
Erodium	*cicutarium*	redstem filaree		X		X	X	X			X					
Erysimum	*repandum*	bushy wallflower					X			X	X					
Euphorbia	*agraria*	urban spurge				X										
Euphorbia	*cyparissias*	cypress spurge				X				X					X	
Euphorbia	*helioscopia*	sun spurge					X						X			
Festuca	*arundinacea*	tall fescue		X									X			
Festuca	*ovina*	sheep fescue				X										
Festuca	*pratensis*	meadow fescue		X			X			X	X			X		
Festuca	*rubra*	red fescue		X	X		X	X								
Filago	*arvensis*	field filago		X						X		X	X			
Fumaria	*officinalis*	common fumitory			X					X						
Galeopsis	*tetrahit*	common hemp nettle		X	X	X										
Galium	*verum*	yellow bedstraw		X		X	X				X					
Geranium	*pusillum*	smallflower geranium		X			X					X				
Glaucium	*corniculatum*	red horn poppy			X											
Glecoma	*hederacea*	ground ivy		X	X	X	X									
Hesperis	*matronalis*	damesrocket		X	X	X				X	X	X	X	X		
Hibiscus	*trionum*	venice mallow		X	X											
Holosteum	*umbellatum*	umbrella spurry								X						
Hordeum	*geniculatum*	Mediterranean barley													X	
Hordeum	*vulgare*	common barley						X		X	X					
Iberis	*umbellata*	globe candytuft					X									
Knautia	*arvensis*	bluebuttons		X		X	X									

APPENDIX B
INVASIVE SPECIES IN OR NEAR THE CUSTER NF

Invasive Species in or near the Custer National Forest				Beartooth Area						Ashland Area				Sioux Area		
Genus	Species	Common Name	Noxious In	Carbon, MT	Stillwater, MT	Sweet Grass, MT	Park, MT	Park, WY	Bighorn, WY	Bighorn, MT	Sheridan, WY	Powder River, MT	Rosebud, MT	Crook, WY	Carter, MT	Harding, SD
Lactuca	*serriola*	prickly lettuce		X	X					X		X				
Lamium	*amplexicaule*	henbit		X	X		X	X				X				
Lappula	*echinata*	European sticktight		X			X			X	X				X	
Lathyrus	*latifolius*	everlasting peavine			X											
Lathyrus	*tuberosus*	earth nut peavine		X			X									
Leonurus	*cardiaca*	motherwort				X										
Lepidium	*campestre*	field pepperweed		X	X		X				X					
Lepidium	*perfoliatum*	clasping pepperweed		X	X		X		X	X			X		X	
Lepidium	*sp.*	whitetop			X		X									
Linum	*usitatissimum*	cultivated flax				X										
Lithospermum	*arvense*	corn gromwell		X	X	X	X									
Lolium	*perenne*	perennial ryegrass					X			X						
Lolium	*persicum*	Persian darnel		X			X			X						
Lonicera	*tatarica*	Tatarian honeysuckle		X	X	X				X						
Lotus	*corniculatus*	birdsfoot trefoil		X	X		X									
Lychnis	*dioica*	red campion				X										
Lycium	*halimifolium*	matrimonyvine					X			X		X		X		
Malcolmia	*africana*	malcolm stock		X												
Malva	*moschata*	musk mallow									X					
Malva	*parviflora*	little mallow					X			X						
Malva	*rotundifolia*	common mallow			X					X	X			X	X	
Malva	*sylvestris*	high mallow		X	X											
Malva	*verticillata*	clustered mallow						X								
Marrubium	*vulgare*	white horehound		X	X		X					X	X			
Matricaria	*matricarioides*	pineapple weed		X	X		X	X	X							
Medicago	*falcata*	sickle medic					X									
Medicago	*lupulina*	black medic		X	X	X	X	X	X	X	X		X	X		
Medicago	*sativa*	alfalfa		X	X	X	X			X						
Melilotus	*albus*	white sweetclover			X					X	X	X			X	
Melilotus	*officinalis*	yellow sweetclover				X	X	X		X	X	X		X	X	
Morus	*alba*	white mulberry					X									
Nasturtium	*officinale*	watercress		X			X									
Nepeta	*cataria*	catnip									X	X		X		
Onobrychis	*viciifolia*	sainfoin				X	X				X					
Papaver	*argemone*	pinnate poppy														
Papaver	*rhoeas*	corn poppy			X											
Pastinaca	*sativa*	wild parsnip		X		X	X				X					
Phleum	*pratense*	timothy		X	X	X	X	X	X		X		X	X	X	
Plantago	*lanceolata*	buckhorn plantain		X		X		X			X					
Poa	*annua*	annual bluegrass		X	X	X		X								
Poa	*bulbosa*	bulbous bluegrass		X	X		X			X	X	X	X	X		
Poa	*compressa*	Canada bluegrass		X	X	X	X	X		X	X	X	X	X	X	
Poa	*palustris*	fowl bluegrass		X		X	X	X		X	X		X	X		
Poa	*pratensis*	Kentucky bluegrass		X	X	X	X	X	X	X	X	X	X	X	X	

APPENDIX B
INVASIVE SPECIES IN OR NEAR THE CUSTER NF

Invasive Species in or near the Custer National Forest				Beartooth Area						Ashland Area				Sioux Area		
Genus	Species	Common Name	Noxious In	Carbon, MT	Stillwater, MT	Sweet Grass, MT	Park, MT	Park, WY	Bighorn, WY	Bighorn, MT	Sheridan, WY	Powder River, MT	Rosebud, MT	Crook, WY	Carter, MT	Harding, SD
Polygonum	*convolvulus*	black bindweed		X	X		X	X		X	X		X	X		
Polygonum	*hydropiper*	marshpepper smartweed		X												
Polygonum	*lapathifolium*	pale smartweed		X	X					X	X				X	
Polygonum	*persicaria*	ladysthumb		X		X			X	X						
Polypogon	*monspeliensis*	rabbitfoot polypogon		X				X	X							
Populus	*alba*	white poplar		X	X								X			
Portulaca	*oleracea*	common purslane							X		X				X	
Potentilla	*argentea*	silvery cinquefoil		X	X					X						
Prunus	*tomentosa*	nanking cherry								X						
Puccinellia	*distans*	weeping alkaligrass					X	X					X			
Pyrus	*malus*	common apple			X											
Ranunculus	*repens*	creeping buttercup					X									
Ranunculus	*testiculatus*	bur buttercup		X				X		X		X		X		
Raphanus	*raphanistrum*	wild radish			X											
Raphanus	*sativus*	wild radish									X					
Reseda	*lutea*	yellow mignonette					X									
Rhamnus	*cathartica*	European buckthorn		X	X											
Rumex	*acetosella*	red sorrel		X	X			X		X						
Rumex	*crispus*	curly dock		X	X		X	X	X	X	X			X	X	
Rumex	*patientia*	spinach dock			X										X	
Salix	*fragilis*	crack willow					X									
Salsola	*iberica*	Russian thistle		X		X	X	X	X	X	X	X		X		
Salvia	*nemorosa*	violet sage		X	X	X	X									
Sanguisorba	*minor*	salad burnet				X										
Saponaria	*officinalis*	bouncingbet		X									X			
Scleranthus	*annuus*	knawel		X												
Scolochloa	*festucacea*	sprangletop						X								
Sedum	*acre*	mossy stonecrop				X										
Senecio	*vulgaris*	common groundsel		X		X						X		X		
Setaria	*glauca*	yellow foxtail		X					X	X			X			
Setaria	*italica*	foxtail millet														
Setaria	*verticillata*	bristly foxtail		X						X			X			
Setaria	*viridis*	green foxtail		X	X		X		X	X	X	X	X	X	X	
Silene	*cserei*	smooth catchfly				X	X						X			
Silene	*dichotoma*	hairy catchfly					X									
Silene	*latifolia*	white catchfly		X		X	X	X			X			X		
Silene	*noctiflora*	nightflowering catchfly		X	X											
Silene	*vulgaris*	bladder campion		X	X	X		X								
Sisymbrium	*altissimum*	tall tumblemustard		X	X		X	X		X		X	X	X		
Sisymbrium	*loeselii*	tall hedge mustard								X						
Solanum	*dulcamara*	bittersweet nightshade		X	X	X	X			X		X				
Solanum	*sarrachoides*	hairy nightshade		X					X	X			X			
Sonchus	*asper*	spiny sowthistle		X	X	X				X	X		X			
Sonchus	*oleraceus*	annual sowthistle						X					X			

APPENDIX B
INVASIVE SPECIES IN OR NEAR THE CUSTER NF

Invasive Species in or near the Custer National Forest				Beartooth Area						Ashland Area				Sioux Area		
Genus	Species	Common Name	Noxious In	Carbon, MT	Stillwater, MT	Sweet Grass, MT	Park, MT	Park, WY	Bighorn, WY	Bighorn, MT	Sheridan, WY	Powder River, MT	Rosebud, MT	Crook, WY	Carter, MT	Harding, SD
Spergularia	*rubra*	red sandspurry					X									
Stellaria	*media*	chickweed		X	X	X	X			X		X			X	
Symphytum	*officinale*	common comfrey				X										
Taraxacum	*laevigatum*	red seeded dandelion				X	X			X	X	X			X	
Taraxacum	*officinale*	dandelion		X	X	X	X	X	X	X	X	X	X	X	X	
Thlaspi	*arvense*	field pennycress		X	X	X	X	X	X	X	X	X	X	X	X	
Tragopogon	*dubius*	western salsify		X	X	X	X	X	X	X	X	X	X	X	X	
Tragopogon	*miscellus*	hybrid salsify		X							X					
Tragopogon	*porrifolius*	common salsify			X			X	X		X					
Tragopogon	*pratensis*	meadow salsify		X		X	X			X					X	
Trifolium	*dubium*	small hop clover		X												
Trifolium	*fragiferum*	strawberry clover		X	X											
Trifolium	*hybridum*	alsike clover			X		X	X								
Trifolium	*pratense*	red clover			X	X	X	X						X		
Trifolium	*repens*	white clover				X	X	X	X	X				X		
Triticum	*aestivum*	cultivated wheat											X			
Vaccaria	*pyramidata*	cowcockle		X	X		X	X	X		X	X		X	X	
Verbascum	*blattaria*	moth mullein								X						
Verbascum	*thapsus*	common mullein		X	X		X	X	X		X			X		
Veronica	*biloba*	bilobed speedwell		X		X										
Veronica	*officinalis*	common speedwell					X									
Veronica	*serpyllifolia*	thymeleaf speedwell		X					X							
Vicia	*cracca*	bird vetch				X										
Vicia	*villosa*	hairy vetch									X					

APPENDIX B
INVASIVE SPECIES IN OR NEAR THE CUSTER NF

The following table outlines invasive species within the Greater Yellowstone Area (GYA) and their estimated infestation density.

TABLE B – 2. DISTRIBUTION OF KEY NOXIOUS AND OTHER INVASIVE PLANT SPECIES ON FEDERAL LANDS IN THE GYA[2]

Scientific Name	Common Name	Custer NF, Beartooth RD	Shoshone NF	Gallatin NF	Beaverhead - Deerlodge NF, Madison RD	Caribou – Targhee NF	Bridger – Teton NF	Red Rock Lake Refuge	National Elk Refuge	Grand Teton NP	Yellowstone NP
Acroptilon repens	Russian knapweed	O	O	+	+	O	+	O	+	+	++
Carduus nutans	Musk thistle	+	++	++++	+++	++++	++++	+	+++	++++	++
Cenaturea diffuse	Diffuse knapweed	O	+	+	+	+	+	O	O	+	+
Centaurea maculosa	Spotted knapweed	+++	++	++++	+++	+++	+++	++	++	+++	+++
Centaurea solstitialis	Yellow starthistle	O	O	O	O	O	O	O	O	O	O
Chondrilla juncea	Rush skeletonweed	O	O	O	O	O	O	O	O	O	O
Chrysanthemum leucanthemum	Oxeye Daisy	++	++	+++	O	+	++	O	++	+++	++
Cirsium arvense	Canada Thistle	++	++++	++++	+++	++++	++++	+++	+++	++++	++++
Cynoglossum officinale	Houndstongue	++	++	+++	+++	+++	+++	+	+	++	++
Euphorbia esula	Leafy spurge	++	++	++++	+	++++	++	O	O	+	+
Hieracium aurantiacum	Orange hawkweed	O	+	+	+	O	O	O	O	+	++
Hieracium pratenses	Yellow hawkweed	O	O	O	O	O	O	O	O	++	++
Hypericum perforatum	St. Johnswort	+	O	++	+	++++	+	+	+++	++	++
Hyoscyamus niger	Black Henbane	O	++	+	+	++++	+++	+	+	+	+
Isatis tinctoria	Dyers woad	O	O	+	O	++++	++	+	O	+	+
Lepidium draba	Whitetop	O	+++	+	+	++	+++	O	++	++	++
Lepidium latifolium	Perennial pepperweed	O	+	O	O	O	++	O	+	+	O
Linaria dalmatica	Dalmatian toadflax	++	++++	++++	O	++	++	O	+	++	++++
Linaria vulgaris	Yellow toadflax	+	+	++++	++	++++	++	O	+	+++	+++
Lythrum salicaria	Purple loosestrife	O	O	O	O	O	O	O	O	O	O
Potentilla recta	Sulfur cinquefoil	++	+	++	O	+	++	O	O	++	+
Ranunculus acris	Tall buttercup	O	O	O	O	O	O	O	O	O	+
Sonchus arvense	Marsh sowthistle	O	O	O	O	O	++	O	O	+	O
Tamarix ramosissima	Tamarisk	O	O	O	O	O	0	O	O	O	+
Tanacetum vulgare	Common Tansy	O	O	++	++	++	++	++	O	++	+

[2] GYCC (Greater Yellowstone Coordinating Committee), 2001. Based on Available Data From FY2000.

O	No evidence on unit to date, or eradicated from unit
+	Trace, less than 5 acres infested
++	Established, 5-100 acres infested
+++	Well established, 100-1000 acres infested
++++	Widely distributed with over 1000 acres infested

APPENDIX C
PROTECTION MEASURES

PROTECTION MEASURES (Design Criteria for Each Alternative)

Tables C – 1 and C - 2 outlines the environmental design criteria that would be implemented under each alternative identified as protection measures. They are grouped as general treatment and aerial treatment protection measures. Appendix N also provides additional aerial spray guidelines. As part of the proposed action design, the protection measures outlined in Table C - 3 are intended *to* minimize contamination of water resources and to minimize injury to non-target desired plants from herbicide use in environmentally sensitive sites. All protection measures apply to Alternative 1, Proposed Action. These management requirements and constraints apply to personnel, contractors, or other partners treating weeds on the Custer National Forest. It outlines the issue area, objective, effectiveness, and applicable alternative for each protection measure. Best Management Practices (BMPs) outlined in Appendix D are additional protection measures applied to each alternative.

TABLE C – 1. GENERAL PROTECTION MEASURES

General Protection Measures	Alternative Applied	Issue Area & Effectiveness[1]
Prevention. Follow Appendix D Best Management Practices for Prevention. Ensure all Forest Service employees are aware of and knowledgeable about Noxious Weeds (FSM 2081.2 11). All employees will inspect, remove and properly dispose of weed seed and plant parts found on their clothing and equipment including Forest Service vehicles and all terrain vehicles (FSM 2081.2 11). Implement prevention and protection measures as outlines in FSM 2080.	1, 2, 3	Effectiveness of Treatment Minimize seed spread; High effectiveness; Logical
Proper Training and Safety Instruction: Herbicides would be used in accordance with US Environmental Protection Agency label instructions and restrictions. Label restrictions on herbicides are developed to mitigate, reduce, or eliminate potential risks to humans and the environment. Label information and requirements include: Personal Protective Equipment; User Safety, First Aid; Environmental Hazards; Directions for Use; Storage and Disposal; General Information; Mixing and Application Methods; Approved Uses; Weeds Controlled; and Application Rates. All guidelines and protection measures presented in the Forest Service Manual 2150, Pesticide Use Management and Coordination, and in the Forest Service Handbook 2109.14, Pesticide Use Management and Coordination Handbook, will be adhered to. Applicators or operators must wear all protective gear required on the label of the herbicide they are using (FSH 6709.11). Application would be done or supervised by licensed applicators, as required by law. Operators should calibrate spray equipment at regular intervals to ensure proper rates of herbicide applications (see Appendix K). Maintain personnel hygiene when spraying is complete (see Appendix M). Records of herbicide use will be recorded daily in a herbicide use log, including: temperature, wind speed, and direction; herbicide and formulation uses; quantity of herbicide and dilutents applied; location and method of application; acreage; and persons applying herbicides. Herbicide applicators will be advised of the potential for herbicides to run off into streams and will not initiate spraying when heavy rains are forecast that could cause offsite herbicide transport into sensitive resources such as streams. Herbicide effectiveness can also be compromised if spraying occurs too close to heavy rainfall occurrence (see Appendix J and label for Rainfastness information).	1, 3	Human Health Water Quality & Aquatics Ensure responsible application of herbicide; High effectiveness; Professional experience
Weather Monitoring: Weather conditions would be monitored on-site (temperature, humidity, wind speed. Direction), and spot forecasts would be reviewed for adverse weather conditions.	1, 3	Drift Reduction and Herbicide Effectiveness Ensure responsible application of herbicide; High effectiveness; Professional experience

[1] The effectiveness column used the following definitions for rating purposes.
High: Protection measures are very effective (estimated to be 90 percent effective). Documentation of effectiveness is available in literature; professional judgment based on previous experience, or applied logic.
Moderate: Protection measures are reasonably effect (estimated between 40 to 89 percent effective). Documentation of effectiveness is available in literature; professional judgment based on previous experience, or applied logic.
Low: Protection measures are somewhat effective (estimated at less than 40 percent). Documentation of the effectiveness is unavailable or professional judgment indicates success is uncertain. Implementation of the protection measure needs to be monitored and the measure may need to be modified if necessary to achieve the objective.
Unknown: Effectiveness is unknowns or unverified; there is little or no documentation, or applied logic is uncertain. The protection measure needs both effectiveness and validation monitoring to determine success in meeting objective.

APPENDIX C
PROTECTION MEASURES

General Protection Measures	Alternative Applied	Issue Area & Effectiveness[1]
Travel Plan Adherence: Treatment activities in designated Wilderness and Research Natural Areas will follow local motorized travel management plan or applicable public land laws, rules, regulations, and orders. Variances to motorized travel plans may be allowed for administrative motorized access to conduct weed treatment activities in areas outside of Wilderness and RNAs.	1, 2	Travel Plan; Special Areas Avoid conflict with other resources: High effectiveness; Logical
Mixing, Loading, Disposal: Procedures for mixing, loading, and disposal of pesticides and a spill plan would be followed (Label and FSH 2109.14, 43). All herbicide storage, mixing, and post-application equipment cleaning is completed in such a manner as to prevent the potential contamination of any perennial or intermittent waterway, unprotected ephemeral waterway or wetland These procedures are outlined in Appendices L and M. Herbicide applicators shall carry spill containment equipment, be familiar with and carry an Herbicide Emergency Spill Plan (see Appendix M).	1, 3	Human Health Water Quality & Aquatics Ensure responsible application of herbicide; High effectiveness; Professional experience
Dyes: Water-soluble colorants, such as Hi-Light® blue dye, would be used in some situations to enable applicators and inspectors to better see where herbicide has been applied.	1	Herbicide Use and Safety – Dye Safe handling of herbicide; Moderate effectiveness; Logical, Appendix J
Ester Formulations Prohibited: Due to toxicity to fish, ester formulations of herbicides (i.e. 2, 4-D ester, triclopyr ester (Garlon 4)) are prohibited from use in streamside or wetland zones where fisheries occur.	1, 3	Aquatics Protect fish resources; Moderate efficiency; EIS Ch. 4, Table 4 - 13
Posting in Public Use Areas: In public recreation areas (such as developed campgrounds, trailheads, other areas of concentrated use) post treated area until the area is safe to re-enter (as defined by the product label, usually 24 to 48 hours).	1,3	Herbicide Use and Safety – Recreation Areas Inform public; Moderate effectiveness; Logical
Herbicide Use Near Potable (Drinking) Water: See Table C - 3 for detailed protection measures in and near surface and ground water. Emphasize non-herbicide alternatives, where feasible. Follow herbicide label restrictions regarding use near functioning potable water sources. Herbicides can have varying setback restrictions near functioning/active potable water intakes. For example, very specific restrictions apply to labels of glyphosate products registered for aquatic weed control state: "*Do not apply this product in flowing water within 0.5 mile up-stream of active potable water intake*". Unless otherwise directed by label, ground herbicide terrestrial application within a 50 foot radius of functioning potable water sources / wellheads should use only glyphosate or 2, 4-D formulations approved for use in or near water.	1	Human Health Protect human health; Moderate efficiency; Logical
Herbicide Use Near Water: See Table C - 3 for detailed protection measures in and near surface and ground water. Emphasize non-herbicide alternatives, where feasible. In watersheds where picloram delivery modeling indicates possible concerns within a watershed (see Ch. 4, Table 4 - 14) use one or more of the following strategies: • Treat some infestations with another appropriate herbicide (see Appendices G & I), • Postpone treatment with picloram for at least a year; and /or • Use biological or mechanical control, where feasible.	1, 3	Aquatics Protect aquatic resources and ground water; Moderate efficiency; EIS Ch. 4-Table 4 - 13
Surfactants Near Water: Only surfactants labeled for use in and around water would be used within 50 feet of water, or the edge of subirrigated land, whichever distance is greater, or on high run-off areas. Some surfactants are labeled for use in and around water including: Activate Plus ®, LI-700 ®, Preference ®, R-11 ®, Widespread® and X-77®. Follow product label.	1	Herbicide Use and Safety & Aquatics – Surfactants Protect Aquatic Resources; High effectiveness; EIS, Appendix J
Risk to Groundwater: See Table C - 3 for detailed protection measures in and near surface and ground water. In areas at high or unacceptable risk to groundwater contamination (see Map section – RAVE Model), use hand applications (spot treat, wick, etc.), or for broadcast application use an alternate herbicide with a lower leachability than clopyralid, dicamba, hexazinone or picloram (see Ch.3, Table 3 -13 for herbicide leachability). Refer to Table C – 3 for herbicide specific applications in these areas.	1, 3	Herbicide Use and Safety Ensure responsible application of herbicide; High effectiveness; Logical, Label advisories.

APPENDIX C
PROTECTION MEASURES

General Protection Measures	Alternative Applied	Issue Area & Effectiveness[1]
Storage Prohibited in Riparian Areas: Storage of fuels and other toxicants within riparian areas and refueling within these areas is prohibited unless there is no other alternative.	1	Aquatics Protect aquatic resources; Moderate efficiency; EIS page 4-23 (INFISH standard FA-4)
Prescribed Burning: All burning would be conducted in accordance with Custer National Forest fire management policy which requires the site specific preparation of a prescribed burn plan before every burn. The prescribed burn plan addresses the objectives of the burn, physical characteristics of the burn area, type of fuels, weather conditions under which the plan will be carried out, expected fire behavior air and water quality restrictions, ignition pattern and sequence, emergency fire control workforce requirements, public contacts, and safety.	1, 2, 3	Burn Treatments Ensure restoration to a diverse plant community; Moderate effectiveness; Professional experience.
Biological Agents: Biological agents would not be released until screened for host specificity and approved by the USDA Animal Plant Health Inspection Service. Protected biocontrol sites can also function as collection points for redistribution of established biocontrols to other sites. Depending upon management objectives, consideration should be given for possible protection of successful biocontrol sites from other management actions that could negatively influence the biocontrol agent (such as burning or application of herbicides).	1, 3	Biological Agents Minimize injury to non-target species; High effectiveness; Logical
Seeding with Native Seed: Seeding with native seed would only occur if desirable competitive plants do not re-emerge and dominate the vegetation community after the weed species is treated. Seed must be certified weed seed free.	1, 2	Cultural Treatments Ensure restoration to a diverse plant community; High effectiveness; Herbicide label
Timing of Mechanical Treatment. To limit the potential for equipment to spread weed seeds, treatments should be completed before seed becomes viable.	1, 2, 3	Effectiveness of Treatment Minimize seed spread.; High effectiveness; Logical
Mechanical Treatment - Sensitive Plant Populations: Mechanical treatment methods that have potential to adversely affect the viability of known sensitive plant species populations will be avoided or mitigated.	1, 2, 3	TES Species Protect sensitive plant resources High effectiveness; Logical
Mechanical Treatment - Heritage Resources: Mechanical or burning treatment methods that have potential to adversely affect heritage resources will follow applicable public land laws (36 CFR 800) and State Historic Preservation Office agreements. Significant sites that could be damaged by a mechanical or burning treatment will be mapped and provided to weed treatment coordinators in order to avoid any damages.	1, 2, 3	Heritage Protect Heritage Resource sites; High effectiveness; Logical
Disposal of Manually Removed Weeds. Disposal of weeds that are grubbed or manually removed will be as follows: If no flowers or seeds are present, pull the weed and place it off the ground, if possible, to dry out. If flowers or seeds are present, pull and place weeds in a plastic bag or a container to retain seeds. Dispose of weeds by burning them or taking them in closed garbage bags to a sanitary landfill.	1, 2, 3	Effectiveness of Treatment Minimize seed spread.; High effectiveness; Logical
Consultation - Tribal: Where traditional cultural plant gathering areas have been identified, following protection measures outlined in this Appendix for sensitive plant populations. Tribal consultation may be done to address any additional mitigation measures needed to minimize effects to various aspects of the activity. These could include, but are not limited to adjusting the timing of the treatment, adjusting the type of treatment, adjusting the priority of the treatment.	1, 2, 3	Heritage Protect Heritage Resource areas; High effectiveness; Logical
Concurrence Required in RNAs: If any treatment with herbicide is planned within RNA boundaries, concurrence must be obtained through the Research Station Director and Forest Supervisor.	1	Special Areas Ensure policy is followed.; High effectiveness; FSM 4060.
Cooperation: In cooperation with federal, state, and county agencies, Custer National Forest System lands within ¼ mile to other ownership would be selectively treated to coincide with active weed management projects on those adjacent lands. Decisions regarding treatment methods and buffer width on land adjacent to privately owned land or land managed by other agencies would be negotiated between the Forest Service and the other owner/agency.	1	Adjacent Land Prevent weeds from spreading onto FS land; Moderate effectiveness; Professional experience

APPENDIX C
PROTECTION MEASURES

General Protection Measures	Alternative Applied	Issue Area & Effectiveness[1]
Coordination - Grazing Restrictions: Coordinate with District Rangeland Management personnel regarding locations of permitted livestock when anticipating using a herbicide that may have grazing restrictions. When applicable, the timing of herbicide treatment will avoid conflict with permitted livestock grazing as required by the herbicide label. See label and Appendix H.	1	Social / Economic Minimize conflicts with permitted livestock High effectiveness Professional experience; Herbicide label
Coordination - Biologists: District/Forest wildlife biologists would review and coordinate weed management projects with the District/Forest weed coordinators to identify current raptor nesting areas, grizzly bear core habitat, wolf territories, or other critical wildlife areas that may be affected by weed control activities, to ensure the protection measures described in this Appendix are implemented properly.	1, 2, 3	TES Species Protect wildlife species from weed control; Moderate Effectiveness; Professional experience
Sensitive Plant Populations: Infested sites would be evaluated for Forest Service regionally listed sensitive plants before treatment. If sensitive plants occur in or near infestations, a weed control plan will be developed to help protect the sensitive plant. Provide weed crews or contractors with maps of all known sensitive plant populations so that these sites can be identified and protected. Provide training for weed crews to identify sensitive plants so that new sites can be identified and protected. Consult with botanist or designated resource specialist prior to treating in sensitive plant habitat with known locations. Use the control method with the least impact on the rare plants (for example, pull non-rhizomatous weeds if the roots of the rare plant will not be detrimentally affected by the soil disturbance). Broadcast (boom) applications of chlorsulfuron or sulfometuron methyl are prohibited within 1500 feet of sensitive plant populations[2]. Selective hand spot or wick treatment with this herbicide is allowed within this setback. Diuron, chlorsulfuron, imazapyr, sulfometuron methyl (broad-spectrum herbicides) are prohibited within the 50-foot buffer zone. Remaining herbicides may be spot applied following label instructions. The broad-spectrum herbicide, glyphosate, may be applied within the 50 buffer, only if the sensitive plant species is dormant. When applying herbicides within 50 feet of sensitive plants, spot treat via hand held wands, backpack sprayers, wick, etc. using herbicide that does not persist in the soil (i.e. picloram, imazapic, diuron are more persistent in soils) (see Table 3 - 13, Ch. 3) and protect sensitive plants from herbicide drift (for example cover plant with plastic when spraying herbicide or use a wick applicator). Ensure that the herbicide used does not target the family of the specific sensitive plant species For example; herbicides targeted for the composite/aster family should not be used near Beartooth Goldenrod populations (i.e. Aminopyralid, Clopyralid). Monocots (species of grass, sedge, and lily families) are tolerant to Clopyralid, 2, 4-D, and triclopyr (i.e. pregnant sedge, yellow lady's slipper). Dicamba and picloram are also considered safe around monocots at lower formulations. If a sensitive plant species is located within a streamside, wetland, groundwater vulnerable, wellhead protection, or woodland zone, that zone's protection measures, if more restrictive, would also apply.	1, 3	TES Species Avoid impact to sensitive plants; Moderate effectiveness; Professional experience and EIS pages 4-57 through 61.
Western Toads and Leopard Frogs: When ground application of herbicide is necessary within 50 feet of a water body, surveys of the treatment area will be required. If adult northern leopard frogs or western toads are identified, the extent of distribution within the proposed treatment area will be marked on the ground and reported to the district amphibian specialist (fisheries or wildlife biologist) and weed coordinator. If treatment is not possible without directly spraying individuals then hand pulling or wick application could be applied. If tadpoles or metamorphs of either species are identified, the location will be reported to the local amphibian specialist (fisheries or wildlife biologist) and weed coordinator, and application of herbicides will be delayed until metamorphs disperse.	1, 3	TES Species, Aquatics Protect aquatic resources and ground water; Moderate efficiency; EIS page 4-54
Bald Eagles: No human activities associated with weed control would be allowed within Zone I (<400 meters [¼ mile]) of an active bald eagle nest from February 1-August 15, except within 20 feet of roads that are open for public motorized use.	1, 2, 3	TES Species Protect eagle; Moderate effectiveness; Conservation Strategy

[2] USDI, BLM, 2005.

General Protection Measures	Alternative Applied	Issue Area & Effectiveness[1]
Wolves and Grizzly Bears: If sheep or goat grazing is prescribed, a herder and guard dogs would be present to monitor sheep and goats used for weed control purposes. The herder must notify the local District Ranger within 24 hours of any loss of sheep or goats. Sheep and goats would be removed from the project area within 24 hours of any grizzly bear or wolf depredations. The herder would be required to comply with the Custer National Forest food storage in order to minimize attractants to bears. The carcasses of sheep or goats that die within a project area must be removed within 24 hours to avoid habituation of grizzly bears or wolves to livestock as carrion. Sheep and goats would be contained each night within the perimeter of an electric fence. Herders would be required to receive training from the U.S. Fish & Wildlife Service or other authorized organization in the use of hazing techniques to prevent depredations by wolves. Herders are required to implement these techniques when wolves are known to be in proximity to the project area.	1, 2, 3	TES Species Protect sheep from predation; Moderate effectiveness; Conservation Strategy, EIS page 4-74.
Wolves: No ground-based spraying would occur within ½ mile of a known wolf den site from April 1 thru June 30 (J. Trapp, MT Fish, Wildlife, and Parks, personal communication on 04/29/05).	1	TES Species Reduce impact to wolves; Moderate effectiveness; EIS page 4-74.
Bighorn Sheep: Proposals for goat or sheep grazing for weed control purposes would be coordinated with the appropriate state wildlife biologist to determine if bighorn sheep may occur in the area. At least nine miles of separation would be maintained between bighorn sheep and domestic sheep or goats being used for weed control purposes.	1, 2	Key Wildlife Species Prevent disease spread; Moderate Effectiveness; Professional experience
Avoid Tree Habitat Mortality: See Table C - 3 for detailed protection measures in and near wooded areas. Herbicides would only be applied at concentrations that would avoid tree mortality to protect potential habitat for bald eagles, lynx, and other key species.	1, 3	TES Species Protect wildlife habitat; Moderate Effectiveness; Logical
Diuron: When using diuron or diuron and sulfometuron methyl mix along paved roads, treat a foot from the shoulders' edge or on other hairline fractures in pavement. Pre-treatment with glyphosate is helpful to reduce existing vegetation.	1	Reduce potential for erosion. Moderate effectiveness Logical, Local Experience

TABLE C – 2. AERIAL PROTECTION MEASURES (SEE APPENDIX N)

Aerial Protection Measures	Alternative Applied	Issues Area & Effectiveness
Aviation Activities. All aviation activities will be in accordance with FSM 5700 (Aviation Management), FSM 2150 (Pesticide Use Management and Coordination), FSH 5709.16 (Flight Operations Handbook), FSH 2109.14, 50 (Quality Control Monitoring and Post-Treatment Evaluation). A project Aviation Safety Plan will be developed prior to aerial spray applications.	1	Human Health & Safety Ensure responsible application of herbicide; High effectiveness; Professional experience
Herbicide Restrictions. Diuron is projected to have limited use since it would typically be used for small amount of infrastructure maintenance (less than 5 acres annually). Aerial application of diuron is not needed and is therefore prohibited.	1	Non-target Species Prohibit aerial use of broad selection herbicide to prevent reaching non-target species; High effectiveness; Logical
Watershed Assessment During Contract Preparation. During contract preparation for aerial application, reassess surface water quality risk with site-specific information. Once the exact treatment areas are delineated in preparation for the contract, determine treatment acres for 6[th] hydrologic unit code (HUC) watersheds potentially affected by aerial application if picloram is used. Incorporate these acres into the risk assessment to estimate probable herbicide concentrations and allowable treatment acres. If concentrations of picloram exceed the recommended safe threshold (see Chapter 4, Table 4-14 Surface Water Risk Analysis), reduce treatment acres to the allowable amount or use herbicides approved for use near surface water.	1	Water Quality & Aquatics Prevent high concentration in surface water; High effectiveness; EIS pages 4-51,52.

APPENDIX C
PROTECTION MEASURES

Aerial Protection Measures	Alternative Applied	Issues Area & Effectiveness
Water Setback. On each side of aquatic, streamside or wetlands zones with, a 300-foot buffer would be established where aerial applications would not be allowed.	1	Water Quality & Aquatics Prevent high concentration of drift from reaching streams & wetlands; High effectiveness; EIS Appendix N Drift Model and USFS Fisheries and Herbicides Work Group Final Findings and Recommendations (March 8, 2004).
Sensitive Plant Setback. Aerial application of chlorsulfuron or sulfometuron methyl will have a setback of 1500 feet from sensitive plant populations. For all other herbicides, a 300-foot buffer would be established where aerial applications would not be allowed adjacent to sensitive plant populations.	1	Non-target Species Minimize effects to sensitive plants; High effectiveness; USDI BLM 2005, ENSR Recommendations
Ground Treatment Within the 300 Foot Aerial Setback. Within 300-foot aerial spray buffers, ground-application of herbicides may occur within protection measures outlined in this Appendix. Herbicide selection would be based on product label restriction, site characteristic evaluation, and protection measures outlined in Tables C – 1 and Table C – 3.	1	Water Quality & Aquatics Treat weeds in buffer area while mitigating resources; High effectiveness; USDA 2001b. page I-8
Minimize Drift. Spray drift is largely a function of droplet particle size, release height, and wind speed. Try to stay within wind speeds up to 6 mph or per label instruction. Incorporate these factors into project design to reduce the risk of drift.	1	Drift Reduction Prevent high concentration of drift from reaching wetlands or other non-target area; High effectiveness; Lolo NF Aerial Guidelines.
Pre-Treatment Mapping. Aerial spray units would be field-validated, flagged, and/or marked using GPS prior to spraying to ensure only appropriate portions of the unit are aerially treated. A GPS system would be used in spray helicopters and each treatment unit mapped before the flight to ensure that only areas marked for treatment are treated.	1	General Ensure accurate location of treatment; High effectiveness; Kulla 2003, page 11-13
Bald Eagles. No aerial spraying would be allowed within Zone I and II (within 1/2 mile) of an active bald eagle nest from February 1 – August 15.	1	TES Species Reduce impact to eagles; Moderate effectiveness; EIS page 4-75.
Goshawks. No aerial spraying would be allowed within ¼ mile of an active goshawk nest from April 1-August 15.	1	TES Species Reduce impact to goshawk; Moderate effectiveness; EIS page 4-78.
Peregrine Falcons. No aerial spraying within one mile of an active peregrine falcon nest from April 1 to August 15.	1	TES Species Reduce impact to peregrine; Moderate effectiveness; EIS page 4-78.
Grizzly Bears. Only 8 hours of aerial spraying would be allowed in grizzly bear core habitat within a given Bear Management Subunit each year.	1	TES Species Reduce impact to grizzly bears; Moderate effectiveness; EIS page 4-71.
Wolves. No aerial spraying would occur within ½ mile of a known wolf den site from April 1 thru June 30 (J. Trapp, MT Fish, Wildlife, and Parks, personal communication on 04/29/05).	1	TES Species Reduce impact to wolves; Moderate effectiveness; EIS page 4-74.

APPENDIX C
PROTECTION MEASURES

Aerial Protection Measures	Alternative Applied	Issues Area & Effectiveness
Designated Wilderness and RNAs. Aerial applications would be excluded from designated Wilderness and Research Natural Areas.	1, 3	Special Areas Avoid conflict with Wilderness Experience or RNA integrity; High effectiveness; Logical
Campgrounds, Residential, Private Land Areas. Provide a minimum buffer of 300 feet for aerial application of herbicides from developed campgrounds, recreation residences and private residential areas (unless otherwise authorized by adjacent private landowners). Treat outside of high use periods where feasible. Temporary closures of campgrounds may be considered to ensure public safety during spray operations.		Human Health and Non-target Vegetation Reduce Drift in areas where People Recreate or Reside and to non-target vegetation; Moderate effectiveness; Logical
Posting. Signing and on site layout would be performed one to two weeks prior to actual aerial treatment.	1	Human Health Provide public notification; Low effectiveness; Logical
Temporary Closures. Temporary area and road/trail closures would be used to ensure public safety during aerial spray operations.	1	Human Health Ensure public safety; High effectiveness; Logical
Communications. Constant communications would be maintained between the helicopter and project leader during spraying operations. Ground observers would have communication with the project leader. Observers would be located at various locations adjacent to the treatment area to monitor wind direction and speed as well as to visually monitor drift and deposition of herbicide.	1	General Ensure safety and implementation of protection measures; High effectiveness; Logical
Monitoring. To reduce risk of effects on aquatic species, aerial spray operations would be closely monitored. Field inspectors will provide on-site monitoring for drift and label compliance. They will be trained and wearing personal protective equipment.	1	Water Quality & Aquatics Ensure implementation of protection measures; High effectiveness; Logical
Monitoring Cards. A field inspector will be present during all aerial application to monitor drift using spray detection cards placed in buffer areas along any stream or lake comprising a sport fishery, or waters important for Threatened, Endangered or Sensitive (TES) aquatic species. Cards will be placed prior to herbicide application and will be sufficient in number and distribution to adequately determine when drift of herbicide into the buffer area exceeds acceptable levels. Spray cards would be placed out to 350 feet from and perpendicular to nearby water bodies, wetlands, or other sensitive areas to monitor herbicide presence. Non-toxic dye would be added to make herbicide visible on spray cards. Dye would allow observers to see herbicide as it is sprayed and to visually monitor drift or vortices from boom and rotor tips.	1	Water Quality & Aquatics Document herbicide disposition; High effectiveness; Logical and Lolo NF Aerial Guidelines.
Equipment & Drift Reduction. Drift reduction agents, nozzles that create large droplets, and special boom and nozzle placement, would be used to reduce drift during aerial spraying.	1	Drift Reduction Control drift; Moderate effectiveness; EIS Appendix J.
Products & Volatility Reduction. Drift control agents may be used in aerial spraying during low humidity to reduce drift into non-target areas. Products that reduce volatility, have been shown to keep droplet sizes larger, and are appropriate adjuvant for the herbicide (as specified by labeling of both the herbicide and the drift agent, in consultation with the herbicide manufacturer) would be used.	1	Drift Reduction Control drift; Moderate effectiveness; EIS Appendix J
Discontinue Treatment. Aerial spraying will be discontinued if herbicide is drifting within the set-back zone and/or wind speed exceeds those recommended on the product's label.	1	Drift Reduction Protect sensitive area; Moderate Effectiveness; Logical

Aerial Protection Measures	Alternative Applied	Issues Area & Effectiveness
Weather. Weather conditions would be monitored on-site (temperature, humidity, wind speed and direction), and spot forecasts would be reviewed for adverse weather conditions.	1	Drift Reduction Control drift; Moderate effectiveness; Logical

Water and Woodlands

Herbicides that are approved for rangeland use are generally benign to soil and soil microorganisms in most soil types. Nevertheless, the specific properties of the herbicides considered do require special attention, particularly when used near surface waters, shallow groundwater, domestic water supply, and woodlands. As part of the proposed action design, the protection measures outlined in Table C - 3 are intended *to minimize* contamination of water resources and to minimize injury to non-target desired woody plants from herbicide use in environmentally sensitive sites (Table C – 1 addresses protection measures pertaining to sensitive plant habitat). These environmentally sensitive sites include

- Aquatic Zone (AZ): The area where aquatic plants (algae, floating plants, submersed plants and emergent plants, i.e. purple loosestrife and water milfoil), grows in ponds, lakes, reservoirs, marshes, drainage ditches, and streams that are still or slow moving.
- Streamside Zone (SZ): Moving water systems (lotic) containing and adjacent to stream channels and floodplains having the presence of obligate &/or facultative riparian vegetation.
- Wetland Zone (WZ) Saturated wetland systems (lentic) that have saturated or seasonally saturated soils and support mostly obligate &/or facultative wetland vegetation &/or aquatic life); includes swamps, bogs, potholes, lakes, ponds, manmade reservoirs & stock ponds.
- Groundwater Vulnerable Zone (GVZ): Shallow groundwater areas underlying permeable soils that is especially vulnerable to contamination from some herbicides. These areas are shown as high or unacceptable vulnerability areas on the RAVE Model Map found in the Map Section - are most often riparian areas.
- Wellhead Protection Areas (WPA): A 50 foot radius around an underground developed and functioning source of drinking water.
- Woodland Zone (WDZ): Hardwood draws, stands of conifers, stands of juniper, aspen groves, and riparian forest stands. Salt Cedar areas are not considered woodlands for use of the following Table.

These protection measures will not guarantee complete abatement of contamination in all areas at all times. Such a guarantee could only be made if the herbicides were not applied. Additional protection measures are found in Table C – 1 and C – 2, and Best Management Practices found in Appendix D.

Table C - 3 describes the protection measures for each environmental zone along with prohibitions or limitations on the use of each herbicide within each zone. Based on the properties and behavior of the herbicides assessed, the herbicides are grouped into three classes for each zone: (i) those that are expressly prohibited, (ii) those that are limited in some defined way, and (iii) those that are generally permitted with no or minor restrictions. Adherence to label directions applies to all herbicides in all zones. See Table C - 2 in Appendix C for Aerial application protection measures.

APPENDIX C
PROTECTION MEASURES

TABLE C – 3. PROPOSED ACTION HERBICIDE-SPECIFIC PROTECTION MEASURES (see bulleted items; adherence to label directions applies to all herbicides in all zones).

Management Zone[3] / General Protection Measures	**Aquatic Zone (AZ)** - still or slow waters with aquatic plants (i.e. purple loosestrife and water milfoil). .[4] • Only those formulations of 2, 4-D, glyphosate, imazapyr, or triclopyr that have been approved for use in or near water are permitted[5]. All other formulations are prohibited. Only surfactants labeled for use in & around water would be permitted.	**Streamside Zone (SZ)[6]** – perennial and intermittent stream riparian areas. • Ground based boom application is allowed up to 50 feet from water's edge. • Application within 50 feet must be done with hand application (hand-held wand, backpack sprayer, wicking etc.) • Wicking applications up to the water's edge is allowed, including use of the otherwise "prohibited" or "limited" herbicides.[7] • Only surfactants labeled for use in and around water would be permitted. • Due to toxicity to fish, ester formulations of herbicides are prohibited where fisheries occur.	**Wetland Zone (WZ)** – seasonal and permanent wetlands. • Same Protection Measures as SZs.	**Groundwater Vulnerable Zone (GVZ)[8]** - shallow groundwater beneath permeable soils; most often are riparian areas.[9]. • Use hand application, or for broadcast application use an alternate herbicide with a lower leachability than clopyralid, dicamba, hexazinone or picloram (see Ch 3, Table 3-13) • The same prohibitions, limitations, and uses listed under the SZs and WZs apply to GVZs with exceptions listed below.	**Wellhead Protection Zone (WPZ)[10]** - a 50 foot radius around a functioning well for drinking water. • Unless otherwise directed by label ground herbicide application within a 50 foot radius of functioning potable water intakes / wellheads should use only glyphosate or 2, 4-D formulations approved for use in or near water.	**Woodland Zone (WZ)** - hardwood draws and conifers (woody weeds, such as salt cedar, are excluded from this category).
2, 4-D[11] Thistles, sulfur cinquefoil, dyers woad, knapweeds, purple loosestrife, Eurasian water milfoil, tall buttercup, whitetop, Some broadleaf, woody and aquatic plants susceptible. Amine is labeled for terrestrial and aquatic use. Hi-Dep IVM is labeled for terrestrial applications, and non-irrigation ditchbanks.	*Use Permitted* • Aquatic formulations only • Consult with Fisheries Specialist. ***Use Prohibited*** Non-aquatic formulations	*Limited Use* • Use only formulations approved for use in or near water. In the amine form or aquatic labeled formulations it can be applied up to the water's edge (without direct contact to the water). ***Use Prohibited*** Non-aquatic formulations	***Same as SZ for 2, 4-D except:*** • Allowed up to 25 feet from water's edge if there is a vegetative buffer[12] with slopes <6%	*Use Permitted* • Aquatic or non-aquatic 2, 4-D may be applied.	***Limited Use*** • Same as SZ and GVZ for 2, 4-D.	*Limited Use* • Spot treatment only within 50 feet of woodlands. Under canopy of desired woody plants, spot apply to foliage of target plants and avoid direct or indirect application to non-target plants or soil.

[3] Follow label direction as it pertains to use in irrigation ditches. Aminopyralid, chlorsulfuron, clopyralid, hexazinone, imazapic, imazapyr, metsulfuron methyl, picloram, and sulfometuron methyl are not permitted within an irrigation ditch even if the ditch is dry per label instruction. Diuron is allowed within a dry irrigation ditch, only per label instruction.

[4] **AZs.** For ponds with heavy weed infestation, partial treatments may be necessary to prevent oxygen depletion & possible fish suffocation associated with decaying vegetation.

[5] **AZs.** These formulations labeled for aquatic use target broadleaf plants (dicots) such as Eurasian water milfoil and purple loosestrife. Most Native azquatic plants are monocots and not susceptible to these chemicals.

[6] **SZs.** Aminopyralid, and formulations of 2, 4-D amine, glyphosate (i.e., Glypro and Rodeo), and triclopyr (i.e. Renovate 3) approved for use in or near water are compatible for use in SZs and can be applied to the water's edge. Glyphosate is injurious to some desired riparian plants, so it must be applied by spot treatments to target plants within a riparian area. Where 5 foot setbacks from water's edge are in place, alternative treatments may include use of permitted herbicides, wick applications, biocontrols, mechanical options, and/or herbivory by goats or sheep.

[7] Although applications by other means are prohibited or limited within 5- feet of water in SZs, wicking application of prohibited herbicides is allowed up to the water's edge due to direct foliage treatment with no drifting or direct application to soil.

[8] Most herbicide groundwater contamination results from "point sources." Point source contaminations include spills or leaks at storage and handling facilities, improperly discarding containers, and rinsing equipment in loading and handling areas, often times into adjacent drainage ditches. Point sources are characterized by discrete, unidentifiable locations discharging relatively high local concentrations. These contaminations can be avoided through proper calibration, mixing, and cleaning of equipment. Non-point source groundwater contaminations of herbicides are relatively uncommon. They can occur, however, when a mobile herbicide is applied in areas with a shallow water table. In this situation, the choice of an appropriate herbicide or alternative control strategy can prevent contamination of the water source. Water tables can shift seasonally and annually; therefore, the depth to water table can be monitored prior to application of a prohibited or limited herbicide within a GVZ. For example, areas that customarily have high water tables early in the growing season may be suitable for herbicide treatment by the fall if preceding precipitation is low. Glyphosate, and amine formulations of 2, 4-D and triclopyr are currently labeled for aquatic use and would be the materials used within designated buffer zones along streams and bodies of water. Imazapic, imazapyr, and triclopyr could be used in buffer zones as long as they would not be directly applied to water.

[9] Most of the GVZs on the Custer NF (about 600 acres) are found along SZs and WZs. Use the same chemical prohibitions, limitations, and uses listed under the SZs and WZs apply to GVZs with the listed exceptions by herbicide.

[10] **WPZs.** Biological controls, herbivory, or mechanical options will be emphasized where feasible and effective.

[11] The more restrictive setback distance in WZs than SZs reflects the persistence of 2,4-D and chlorsulfuron in anaerobic conditions, which are more likely to exist in lentic water systems (wetlands) and wetland soils than in lotic (riverine) environments. **GWZs.** 2, 4-D and glyphosate (formulations approved in and near water) will be the only herbicides approved for use within a WPZ. These chemicals have low to intermediate leaching potential.

[12] Vegetative buffer is an area with good vegetative ground cover. Badlands or other low cover areas with bare ground would not be considered as a vegetative buffer.

APPENDIX C
PROTECTION MEASURES

Management Zone[3] / General Protection Measures	Aquatic Zone (AZ) - still or slow waters with aquatic plants (i.e. purple loosestrife and water milfoil). .[4]	Streamside Zone (SZ)[6] – perennial and intermittent stream riparian areas.	Wetland Zone (WZ) – seasonal and permanent wetlands.	Groundwater Vulnerable Zone (GVZ)[8] - shallow groundwater beneath permeable soils; most often are riparian areas.[9].	Wellhead Protection Zone (WPZ)[10] - a 50 foot radius around a functioning well for drinking water.	Woodland Zone (WZ) - hardwood draws and conifers (woody weeds, such as salt cedar, are excluded from this category).
	• Only those formulations of 2, 4-D, glyphosate, imazapyr, or triclopyr that have been approved for use in or near water are permitted[5]. All other formulations are prohibited. Only surfactants labeled for use in & around water would be permitted.	• Ground based boom application is allowed up to 50 feet from water's edge. • Application within 50 feet must be done with hand application (hand-held wand, backpack sprayer, wicking, etc.). • Wicking applications up to the water's edge is allowed, including use of the otherwise "prohibited" or "limited" herbicides.[7] • Only surfactants labeled for use in and around water would be permitted. • Due to toxicity to fish, ester formulations of herbicides are prohibited where fisheries occur.	• Same Protection Measures as SZs.	• Use hand application, or for broadcast application use an alternate herbicide with a lower leachability than clopyralid, dicamba, hexazinone or picloram (see Ch.3, Table 3 -13). • The same prohibitions, limitations, and uses listed under the SZs and WZs apply to GVZs with exceptions listed below.	• Unless otherwise directed by label, ground herbicide application within a 50 foot radius of functioning potable water intakes / wellheads should use only glyphosate or 2, 4-D formulations approved for use in or near water.	
Aminopyralid[13] Perennial and biennial thistles, knapweeds, sulfur cinquefoil. Tolerated by most grasses. Milestone is labeled for terrestrial applications. Do not apply in surface water	*Use Prohibited*	*Permitted Use* • It can be applied up to the water's edge (without direct contact to the water). • Per label instruction, not to be used in areas of standing water.	*Use Permitted* • Per label instruction, not to be used in areas of standing water.	*Use Permitted*	*Use Prohibited*	*Limited Use* • Spot treatment only within 50 feet of non-targeted woodlands or under canopy of desired woody plants. Do not apply over canopy in non-targeted areas. Avoid direct or indirect application to non-target plants or soil.
Chlorsulfuron[14] • Spot treatment only with hand application methods. Dyer's woad, thistles, common tansy, whitetop, houndstongue, tall buttercup. Some broadleaf plants and grasses susceptible. Telar is labeled for terrestrial use only.	*Use Prohibited*	***Limited Use*** • Do not use in flooded areas or on saturated soils. • Spot treatment allowed up to 5 feet from water's edge. • Use only once per growing season on alkaline soils.	***Same as SZ except:*** • Spot treatment allowed up to 25 feet from water's edge if there is a vegetative buffer with slopes <6%.	***Use Permitted***	***Use Prohibited***	***Limited Use*** • Spot treatment only within 50 feet of non-targeted woodlands or under canopy of desired woody plants. Do not apply over canopy in non-targeted areas. Avoid direct or indirect application to non-target plants or soil.

[13] SZs. ***Limited Herbicides.*** Limitations are imposed based on persistence, transportation pathways, application rates, modes of chemical degradation, and environmental properties of various formulations. The use of aminopyralid is effective on a narrow spectrum of plants (especially knapweeds and thistles) and can generally be used in SZs where standing water does not occur.

[14] SZs. ***Limited Herbicides.*** Limitations are imposed based on persistence, transportation pathways, application rates, modes of chemical degradation, and environmental properties of various formulations. Use of chlorsulfuron must avoid flooded areas and anaerobic conditions, which commonly occur in saturated soils. Also, chlorsulfuron generally targets those plants that prefer upland sites and are not in SZs. The risk of flooding along some perennial streams is seasonal; therefore, use of chlorsulfuron may be restricted temporally during periods when there is a high probability of flooding. The more restrictive setback distance in WZs than SZs reflects the persistence of 2,4-D and chlorsulfuron in anaerobic conditions, which are more likely to exist in lentic water systems (wetlands) and wetland soils than in lotic (riverine) environments.

APPENDIX C
PROTECTION MEASURES

Management Zone[3] / General Protection Measures	Aquatic Zone (AZ) - still or slow waters with aquatic plants (i.e. purple loosestrife and water milfoil). .[4]	Streamside Zone (SZ)[6] – perennial and intermittent stream riparian areas.	Wetland Zone (WZ) – seasonal and permanent wetlands.	Groundwater Vulnerable Zone (GVZ)[8] - shallow groundwater beneath permeable soils; most often are riparian areas.[9].	Wellhead Protection Zone (WPZ)[10] - a 50 foot radius around a functioning well for drinking water.	Woodland Zone (WZ) - hardwood draws and conifers (woody weeds, such as salt cedar, are excluded from this category).
	• Only those formulations of 2, 4-D, glyphosate, imazapyr, or triclopyr that have been approved for use in or near water are permitted[5] All other formulations are prohibited. Only surfactants labeled for use in & around water [illegible] be permitted	• Ground based boom application is allowed up to 50 feet from water's edge. • Application within 50 feet must be done with hand application (hand-held wand, backpack sprayer, wicking, etc.). • Wicking applications up to the water's edge is allowed, including use of the otherwise "prohibited" or "limited" herbicides.[7] • Only surfactants labeled for use in & around water would be permitted • Due to toxicity to fish, ester formulations of herbicides are prohibited where fisheries occur.	• Same Protection Measures as SZs.	• Use hand application, or for broadcast application use an alternate herbicide with a lower leachability than clopyralid, dicamba, hexazinone or picloram (see Ch.3, Table 3 -13). • The same prohibitions, limitations, and uses listed under the SZs and WZs apply to GVZs with exceptions listed below.	• Unless otherwise directed by label, ground herbicide application within a 50 foot radius of functioning potable water intakes / wellheads should use only glyphosate or 2, 4-D formulations approved for use in or near water.	
Clopyralid[15] Thistles, yellow starthistle, hawkweeds, knapweeds, rush skeletonweed, oxeye daisy. Many broadleaf and woody species susceptible. Transline, Stinger, and Reclaim are labeled for terrestrial applications. Do not apply in or near surface water. Do not contaminate water used for irrigation or domestic purposes.	***Use Prohibited***	*Use Prohibited* • Within 50 feet of water's edge. Exception: Wicking applications may occur within 50 feet.	***Same as SZ for Clopyralid***	*Limited Use* • Hand application only Broadcast application prohibited	***Use Prohibited***	*Limited Use* • Spot treatment only within 50 feet of non-targeted woodlands. Under canopy of desired woody plants, spot apply to foliage of target plants and avoid direct or indirect application to non-target plants or soil
Dicamba[16] Houndstongue, knapweeds, oxeye daisy, tall buttercup, leafy spurge, tansy ragwort, common crupina, blueweed, yellow starthistle. Some broadleaf, brush, vines susceptible Vanquish and Banvel are labeled for upland sites and non-irrigation ditchbanks	*Use Prohibited*	***Use Prohibited*** • Within 50 feet of water's edge. Exception: Wicking applications may occur within 50 feet.	*Same as SZ for Dicamba*	***Limited Use*** • Hand application only Broadcast application prohibited.	***Use Prohibited***	***Limited Use*** • Spot treatment only within 50 feet of non-targeted woodlands. Do not use within 3 times the dripline of trees and shrubs (conifers especially sensitive). Avoid direct or indirect application to non-target plants or soil.

[15] SZs: ***Prohibited Herbicides.*** Herbicides that are prohibited within 50 feet of water are very mobile with generally moderate persistence. Triclopyr targets many of the same noxious weeds as clopyralid and has been formulated for use near water. Consequently triclopyr is a more acceptable alternative than clopyralid or metsulfuron methyl in a SZ.

[16] **SZs: *Prohibited Herbicides.*** Herbicides that are prohibited within 50 feet of water are very mobile with generally moderate persistence. Even though dicamba has low persistence, it is very mobile, easily leached, and breaks down slowly in water or in water-saturated soil. The weeds, which dicamba targets, generally do not occur in wetland or riparian settings. Therefore, the prohibition of dicamba has little bearing on management options. **WZs.** Dicamba can injure woody plants by being exuded through weed roots and being uptaken by trees and shrubs within three times their drip lines.

APPENDIX C
PROTECTION MEASURES

Management Zone[3] / General Protection Measures	**Aquatic Zone (AZ)** - still or slow waters with aquatic plants (i.e. purple loosestrife and water milfoil). .[4] • Only those formulations of 2, 4-D, glyphosate, imazapyr, or triclopyr that have been approved for use in or near water are permitted[5]. All other formulations are prohibited. Only surfactants labeled for use in & around water would be permitted.	**Streamside Zone (SZ)[6]** – perennial and intermittent stream riparian areas. • Ground based boom application is allowed up to 50 feet from water's edge. • Application within 50 feet must be done with hand application (hand-held wand, backpack sprayer, wicking, etc.). • Wicking applications up to the water's edge is allowed, including use of the otherwise "prohibited" or "limited" herbicides.[7] • Only surfactants labeled for use in and around water would be permitted. • Due to toxicity to fish, ester formulations of herbicides are prohibited where fisheries occur.	**Wetland Zone (WZ)** – seasonal and permanent wetlands. • Same Protection Measures as SZs.	**Groundwater Vulnerable Zone (GVZ)[8]** - shallow groundwater beneath permeable soils; most often are riparian areas.[9]. • Use hand application, or for broadcast application use an alternate herbicide with a lower leachability than clopyralid, dicamba, hexazinone or picloram (see Ch.3, Table 3 -13). • The same prohibitions, limitations, and uses listed under the SZs and WZs apply to GVZs with exceptions listed below.	**Wellhead Protection Zone (WPZ)[10]** - a 50 foot radius around a functioning well for drinking water. • Unless otherwise directed by label, ground herbicide application within a 50 foot radius of functioning potable water intakes / wellheads should use only glyphosate or 2, 4-D formulations approved for use in or near water.	**Woodland Zone (WZ)** - hardwood draws and conifers (woody weeds, such as salt cedar, are excluded from this category).
Diuron • No aerial spraying Annual weeds and broadleaves for infrastructure maintenance needs such as right-of-ways. Broad spectrum. Diuron 4L Diuron 80 (DF, WDG) Direx 4L Karmex DF (80 DF) is labeled for Uplands, and ditches when water is not present. Irrigation ditches can only be treated in the non-crop season.	*Use Prohibited*	***Use Prohibited*** • Within 50 feet of water's edge. Exception: Wicking applications may occur within 50 feet.	*Use Prohibited*	***Use Permitted***	*Use Prohibited*	***Limited Use*** • Spot treatment only within 50 feet of non-targeted woodlands or under canopy of desired woody plants. Do not apply over canopy in non-targeted areas. Avoid direct or indirect application to non-target plants or soil.
Glyphosate[17] Purple loosestrife, field bindweed, yellow starthistle, thistles, cheatgrass, common crupina, toadflax. Glyphosate does not work on underwater plants such as Eurasian watermilfoil Broad spectrum. Accord, Glypro, and Rodeo are labeled for certain aquatic weed [illegible]. The other products are for terrestrial applications, including ditch banks, and dry ditch or canal bottoms	***Use Permitted*** • Aquatic formulations only • Consult with Fisheries Specialist. ***Use Prohibited*** Non-aquatic formulations	***Limited Use*** • Use only formulations approved for use in or near water (i.e. Glypro, Rodeo). • Spot treat target plants only within riparian area to avoid injury to non-target riparian plants. ***Use Prohibited*** Non-aquatic formulations	***Same as SZ for Glyphosate***	***Use Permitted***	***Use Permitted*** • Use only formulations approved for use in or near water	***Limited Use*** • Spot treatment only within 50 feet of non-targeted woodlands or under canopy of desired woody plants. Avoid direct or indirect application to non-target plants or soil.

[17] **GWZs.** 2,4-D and glyphosate (see specific formulations) will be the only herbicides approved for use within a WPZ. These chemicals have low to intermediate leaching potential.

APPENDIX C
PROTECTION MEASURES

Management Zone[3] / General Protection Measures	**Aquatic Zone (AZ)** - still or slow waters with aquatic plants (i.e. purple loosestrife and water milfoil). .[4]	**Streamside Zone (SZ)[6]** – perennial and intermittent stream riparian areas.	**Wetland Zone (WZ)** – seasonal and permanent wetlands.	**Groundwater Vulnerable Zone (GVZ)[8]** - shallow groundwater beneath permeable soils; most often are riparian areas.[9].	**Wellhead Protection Zone (WPZ)[10]** - a 50 foot radius around a functioning well for drinking water.	**Woodland Zone (WZ)** - hardwood draws and conifers (woody weeds, such as salt cedar, are excluded from this category).
	• Only those formulations of 2, 4-D, glyphosate, imazapyr, or triclopyr that have been approved for use in or near water are permitted[5]. All other formulations are prohibited. Only surfactants labeled for use in & around water are permitted.	• Ground based boom application is allowed up to 50 feet from water's edge. • Application within 50 feet must be done with hand application (hand-held wand, backpack sprayer, wicking, etc.). • Wicking applications up to the water's edge is allowed, including use of the otherwise "prohibited" or "limited" herbicides.[7] • Only surfactants labeled for use in and around water would be permitted. • Due to toxicity to fish, ester formulations of herbicides are prohibited where fisheries occur.	• Same Protection Measures as SZs.	• Use hand application, or for broadcast application use an alternate herbicide with a lower leachability than clopyralid, dicamba, hexazinone or picloram (see Ch.3, Table 3 -13). • The same prohibitions, limitations, and uses listed under the SZs and WZs apply to GVZs with exceptions listed below.	• Unless otherwise directed by label, ground herbicide application within a 50 foot radius of functioning potable water intakes / wellheads should use only glyphosate or 2, 4-D formulations approved for use in or near water.	
Hexazinone Poison Hemlock, Cheatgrass, oxeye daisy, yellow starthistle, thistles. Broad spectrum control with some selectivity for conifers. Velpar and Pronone are labeled for terrestrial applicaionts.	*Use Prohibited*	*Use Prohibited* • Within 50 feet of water's edge. Exception: Wicking applications may occur within 50 feet.	*Same as SZ for Hexazinone*	*Limited Use* • Hand application only. Broadcast application prohibited.	*Use Prohibited*	*Limited Use* • Follow Label direction in and near conifers. • Spot treatment only within 50 feet of non-targeted woodlands or under canopy of desired woody plants. Avoid direct or indirect application to non-target plants or soil.
Imazapic[18] Cheatgrass, leafy spurge, toadflax. Some broadleaf plants and grasses susceptible. Plateau is labeled for terrestrial use only. Do not apply near water.	*Use Prohibited*	*Limited Use* • Maximum of 0.188 lb a.e./ac • Allowed up to 5 feet from water's edge if there is a vegetative buffer that has slopes <6%	*Same as SZ for Imazapic*	*Limited Use* • Maximum of 0.188 lb a.e./ac. • Exception: No slope limitations	*Use Prohibited*	*Limited Use* • When making fall applications, potential injury to tree and brush species from foliar contact may be minimized by making the application after the leaves have begun to senesce (fall color) or after leaf drop. Conifers are generally tolerant to fall applications. Applications in and around tree and brush species should be made at the recommended timing for the target weed species.

- [18] **SZs.** ***Limited Herbicides.*** Limitations are imposed based on persistence, transportation pathways, application rates, modes of chemical degradation, and environmental properties of various formulations. The use of imazapic is desirable because it acts on a narrow spectrum of plants and is generally non-injurious to non-target forbs at low application rates and when applied after seed-set has occurred. Furthermore, imazapic is rapidly photodegraded by sunlight in surface waters. Imazapic and imazapyr are limited to reaches where a well vegetated buffer zone exists and grounds slopes are less than 6 percent between the application site and surface water. These requirements are imposed to keep these herbicides from entering surface water via runoff from overland flow. Also, the maximum application rate for imazapic is 0.188 lb acid equivalent/acre, based on studies that demonstrate limited mobility at this and lower application rates (BASF Corporation, 2006, p. 4). The slope restrictions on imazapic and imazapyr do not apply within a GVZ because physical translocation of soil-adsorbed chemicals will not affect the groundwater.

APPENDIX C
PROTECTION MEASURES

Management Zone[3] **/ General Protection Measures**	**Aquatic Zone (AZ)** - still or slow waters with aquatic plants (i.e. purple loosestrife and water milfoil). .[4] • Only those formulations of 2, 4-D, glyphosate, imazapyr, or triclopyr that have been approved for use in or near water are permitted[5]. All other formulations are prohibited. Only surfactants labeled for use in & around water would be permitted.	**Streamside Zone (SZ)**[6] – perennial and intermittent stream riparian areas. • Ground based boom application is allowed up to 50 feet from water's edge. • Application within 50 feet must be done with hand application (hand-held wand, backpack sprayer, wicking, etc.). • Wicking applications up to the water's edge is allowed, including use of the otherwise "prohibited" or "limited" herbicides.[7] • Only surfactants labeled for use in and around water would be permitted. • Due to toxicity to fish, ester formulations of herbicides are prohibited where fisheries occur.	**Wetland Zone (WZ)** – seasonal and permanent wetlands. • Same Protection Measures as SZs.	**Groundwater Vulnerable Zone (GVZ)**[8] - shallow groundwater beneath permeable soils; most often are riparian areas.[9]. • Use hand application, or for broadcast application use an alternate herbicide with a lower leachability than clopyralid, dicamba, hexazinone or picloram (see Ch.3, Table 3 -13). • The same prohibitions, limitations, and uses listed under the SZs and WZs apply to GVZs with exceptions listed below.	**Wellhead Protection Zone (WPZ)**[10] - a 50 foot radius around a functioning well for drinking water. • Unless otherwise directed by label, ground herbicide application within a 50 foot radius of functioning potable water intakes / wellheads should use only glyphosate or 2, 4-D formulations approved for use in or near water.	**Woodland Zone (WZ)** - hardwood draws and conifers (woody weeds, such as salt cedar, are excluded from this category).
Imazapyr[19] Salt Cedar. Purple loosestrife, dyers woad, field bindweed. Imazapyr does not work on underwater plants such as Eurasian watermilfoil. Broad spectrum. Arsenal is labeled for uplands, non-tidal wetlands where surface water is not present, non-irrigation ditchbanks, and ditchbottoms where only isolated puddles of surface water occur.	*Use Permitted* • Consult with Fisheries Specialist.	*Limited Use* • Use of Habitat or Arsenal on cut stump or hand spraying salt cedar may come into contact with surface water per label instruction. • For all other species, use of imazapyr is allowed up to 5 feet from water's edge if there is a vegetative buffer that has slopes <6%.	*Same as SZ for Imazapyr*	*Use Permitted* • Exception. No slope limitations	*Use Prohibited*	*Limited Use* • Spot treatment only within 50 feet of non-targeted woodlands or under canopy of desired woody plants. Avoid direct or indirect application to non-target plants or soil.
Metsulfuron methyl[20][21] Houndstongue, thistle, sulfur cinquefoil, common crupina, dyers woad, purple loosestrife, common tansy, whitetop, blueweed. Escort is labeled for Terrestrial applications. Escort can be applied to floodplains, terrestrial areas of deltas, and drained areas of low-lying areas where there may be isolated puddles.	*Use Prohibited*	*Use Prohibited* • Within 50 feet of water's edge. Exception: Wicking applications may occur within 50 feet	*Same as SZ for Metsulfuron methyl*	*Use Prohibited*	*Use Prohibited*	*Limited Use* • Spot treatment only within 50 feet of woodlands or under canopy of desired woody plants. Do not apply over canopy in non-targeted areas. Avoid direct or indirect application to non-target plants or soil.

[19] **SZs. *Limited Herbicides.*** Limitations are imposed based on persistence, transportation pathways, application rates, modes of chemical degradation, and environmental properties of various formulations. Imazapic and imazapyr are limited to reaches where a well vegetated buffer zone exists and grounds slopes are less than 6 percent between the application site and surface water. These requirements are imposed to keep these herbicides from entering surface water via runoff from overland flow. Imazapyr may be transported on eroded soil particles. Setback and vegetation buffer limitations have been applied to minimize soil transport when imazapyr is applied near water. The slope restrictions on imazapic and imazapyr do not apply within a GVZ because physical translocation of soil-adsorbed chemicals will not affect the groundwater.

[20] **SZs: *Prohibited Herbicides.*** Herbicides that are prohibited within 50 feet of water are very mobile with generally moderate persistence. Metsulfuron methyl is slow to break down in surface water, especially alkaline waters. Triclopyr is a more acceptable alternative than clopyralid or metsulfuron methyl in a SZ.

APPENDIX C
PROTECTION MEASURES

Management Zone[3] / General Protection Measures	Aquatic Zone (AZ) - still or slow waters with aquatic plants (i.e. purple loosestrife and water milfoil). .[4]	Streamside Zone (SZ)[6] – perennial and intermittent stream riparian areas.	Wetland Zone (WZ) – seasonal and permanent wetlands.	Groundwater Vulnerable Zone (GVZ)[8] - shallow groundwater beneath permeable soils; most often are riparian areas.[9].	Wellhead Protection Zone (WPZ)[10] - a 50 foot radius around a functioning well for drinking water.	Woodland Zone (WZ) - hardwood draws and conifers (woody weeds, such as salt cedar, are excluded from this category).
	• Only those formulations of 2, 4-D, glyphosate, imazapyr, or triclopyr that have been approved for use in or near water are permitted[5]. All other formulations are prohibited. Only surfactants labeled for use in & around water [illegible]	• Ground based boom application is allowed up to 50 feet from water's edge. • Application within 50 feet must be done with hand application (hand-held wand, backpack sprayer, wicking. etc.). • Wicking applications up to the water's edge is allowed, including use of the otherwise "prohibited" or "limited" herbicides.[7] • [illegible] use [illegible] around water would be permitted. • Due to toxicity to fish, ester formulations of herbicides are prohibited where fisheries occur.	• Same Protection Measures as SZs.	• Use hand application, or for broadcast application use an alternate herbicide with a lower leachability than clopyralid, dicamba, hexazinone or picloram (see Ch 3, Table 3 -13). • The same prohibitions, limitations, and uses listed under [illegible] SZs and WZs apply [illegible] with exceptions listed below.	• Unless otherwise directed by label, ground herbicide application within a 50 foot radius of functioning potable water intakes / [illegible] should use only glyphosate or 2, 4-D formulations approved for use in or near water.	
Picloram[22] Thistles, yellow starthistle, common crupina, hawkweeds, knapweeds, rush skeleton weed, common tansy, toadflax, leafy spurge. Grasses are tolerant. Tordon is labeled for Terrestrial applications. Should not be used where conditions favor off-site movement due to leaching or run-off.	***Use Prohibited***	***Use Prohibited*** • Within 50 feet of water's edge. Exception: Wicking applications may occur within 50 feet.	***Same as SZ for picloram***	***Limited Use*** • Hand application only. Broadcast application prohibited	***Use Prohibited***	***Limited Use*** • Spot treatment only within 50 feet of non-targeted woodlands or under canopy of desired woody plants, especially within 3 times the dripline of trees and shrubs. Avoid direct or indirect application to non-target plants or soil.
Sulfometuron methyl[23] • Spot treatment only with hand application methods. Cheatgrass, whitetop, oxeye daisy, tansy ragwort, musk thistle. Broad spectrum Oust: - Do not apply near open water.	***Use Prohibited*** • Broadcast application prohibited within 100 feet of AZs.[24] • Aerial application prohibited within 1500 feet of AZs.[25]	***Limited Use*** • Allowed up to 25 feet from water's edge if there is a vegetative buffer with slopes <6%.	***Same as SZ for sulfometuron methyl***	***Use Permitted***	*Use Prohibited*	***Limited Use*** • Spot treatment only within 50 feet of woodlands or under canopy of desired woody plants. Do not apply over canopy in non-targeted areas. Avoid direct or indirect application to non-target plants or soil.

[22] **WZs.** Picloram can injure woody plants by being exuded through weed roots and being uptaken by trees and shrubs within three times their drip lines.
[23] **SZs.** Sulfometuron methyl limitations are designed to prevent transportation to surface water by overland flow.
[24] USDI BLM, 2005.
[25] USDI BLM, 2005.

APPENDIX C
PROTECTION MEASURES

Management Zone[3] / General Protection Measures	**Aquatic Zone (AZ)** - still or slow waters with aquatic plants (i.e. purple loosestrife and water milfoil). .[4] • Only those formulations of 2, 4-D, glyphosate, imazapyr, or triclopyr that have been approved for use in or near water are permitted[5]. All other formulations are prohibited. Only surfactants labeled for use in & around water would be permitted.	**Streamside Zone (SZ)[6]** – perennial and intermittent stream riparian areas. • Ground based boom application is allowed up to 50 feet from water's edge. • Application within 50 feet must be done with hand application (hand-held wand, backpack sprayer, wicking, etc.). • Wicking applications up to the water's edge is allowed, including use of the otherwise "prohibited" or "limited" herbicides.[7] • Only surfactants labeled for use in and around water would be permitted. • Due to toxicity to fish, ester formulations of herbicides are prohibited where fisheries occur.	**Wetland Zone (WZ)** – seasonal and permanent wetlands. • Same Protection Measures as SZs.	**Groundwater Vulnerable Zone (GVZ)[8]** - shallow groundwater beneath permeable soils; most often are riparian areas.[9]. • Use hand application, or for broadcast application use an alternate herbicide with a lower leachability than clopyralid, dicamba, hexazinone or picloram (see Ch.3, Table 3 -13). • The same prohibitions, limitations, and uses listed under the SZs and WZs apply to GVZs with exceptions listed below.	**Wellhead Protection Zone (WPZ)[10]** - a 50 foot radius around a functioning well for drinking water. • Unless otherwise directed by label, ground herbicide application within a 50 foot radius of functioning potable water intakes / wellheads should use only glyphosate or 2, 4-D formulations approved for use in or near water.	**Woodland Zone (WZ)** - hardwood draws and conifers (woody weeds, such as salt cedar, are excluded from this category).
Triclopyr[26] • Do not use high application rates in order to avoid potential hazards to birds and mammals • The use of triclopyr is limited to selective application techniques only (e.g., spot spraying, wiping, basal bark, cut stump, injection). No aerial spraying. Purple loosestrife, Eurasian watermilfoil, Hawkweeds, sulfur cinquefoil, knapweed oxeve daisy, thistle. Woody, some broadleaf, & root-sprouting species are susceptible. Grasses are tolerant. Renovate3 (TEA formulation) is labeled for aquatic applications. Garlon 3A, Garlon 4, and Pathfinder [illegible] dry wetlands, floodplains, deltas and transition areas between uplands and wetlands. Do not apply directly to water.	*Use Permitted* • Aquatic formulations only • Consult with Fisheries Specialist. ***Use Prohibited*** • **Non-aquatic formulations**	*Limited Use* • Use only formulations approved for use in or near water. Aquatic labeled formulations can be applied up to the water's edge (without direct contact to the water). ***Use Prohibited*** **Non-aquatic formulations**	*Same as SZ for triclopyr*	*Use Permitted*	*Use Prohibited*	*Limited Use* • Spot treatment only within 50 feet of non-targeted woodlands or under canopy of desired woody plants. Avoid direct or indirect application to non-target plants or soil.

[26] SZs: ***Prohibited Herbicides.*** Herbicides that are prohibited within 50 feet of water are very mobile with generally moderate persistence. Triclopyr targets many of the same noxious weeds as clopyralid and has been formulated for use near water. Consequently triclopyr is a more acceptable alternative than clopyralid or metsulfuron methyl in a SZ.

PREVENTION

Preventing introduction and spread of weeds is one objective of the integrated weed management program on the Forest. Having knowledge of weed spread vectors and conditions in which weed establishment is most vulnerable can help in evaluating spread risk. Project risk assessments evaluate the risk of weed spread due to any proposed activity. Best management practices (BMPs) help in project design and decisions to help minimize spread or new establishment.

WEED SPREAD VECTORS

Weeds are spread by various transport vectors.

- **Weeds can be spread by vehicles.** The source of many weed infestations has been traced to roads, trails, parking lots, gravel pits, railroads, and other travel corridors. When driven through a weed-infested area, weed seeds may become lodged between the tire tread, in a winch, and in other cracks and crevices on the chassis of a vehicle. Such seeds may become dislodged hundreds of miles away, infesting new areas. Most aquatic weeds are spread by human activities, generally through contamination of boats and nets. Weed seed can also be transported in gravel pit material.
- **Weeds can be spread by humans and animals.** Many weed seeds can pass through an animal's digestive tract and still grow. Pack animals that have eaten contaminated feed can deposit weed seeds throughout backcountry areas. Birds and wildlife can move weed seed to even the most remote locations. Livestock, pets, and humans can carry burred seed that cling onto fur or fabric, such as houndstongue seed. Weed seed infested hay, pellets, or straw transported into trailheads or camping sites are another source of spread. Weeds can be spread by those who pick them for floral arrangements. New weed infestations can be established when seeds fall off transported flowers. Some weeds can develop roots and produce new plants directly from plant parts, even after weeks of use as decorations.
- **Weeds can be spread by water and wind.** Many weed seeds have mechanisms allowing to be carried by the wind. Surface water run-off or water naturally flooding and receding in stream systems can also carry weed seed.

WEED SUSCEPTIBILITY

Environmental and land use conditions determine the potential for a weed to establish and survive in a particular setting. Some of the following factors are important to the suitability of land to support a weed:

- **Elevation** -- certain weed species can grow at various elevations, but often not higher than a certain value. This factor limits the potential for a weed to exist in elevation ranges that it is not typically found.
- **Slope --** weeds, as with most plants, are limited by the slope angle on which they can establish and flourish. This factor limits the potential for a weed to exist in steeper slope areas.
- **Aspect** -- weeds are more likely to establish on ground facing in certain directions. Most weeds seem to flourish on more south-facing slopes. This, of course, depends on the species.
- **Land Cover** -- the type of vegetation predominately occupying an area can determine the ability for a weed species to establish. Some land cover types are more susceptible to weed infestations.
- **Soil pH** -- each weed species can grow in soils with a certain pH range. Any soils with a pH outside that range will often limit the growth of that species.
- **Soil Texture** -- as with pH, certain species can grow in different soil types. This factor limits the potential for a weed to grow in certain soil types.
- **Precipitation** -- if a weed needs a lot of moisture to survive, there needs to be an adequate amount of annual precipitation in an area for that weed. This factor determines where a weed can grow based on the precipitation regime. Some species favor arid climates, whereas other species need more moisture.
- **Distance from Water Sources** -- similar to precipitation, this factor limits the places some species can flourish based on the availability of water. A more water-dependent species may need to be located closer to a constant water source in order to survive and invade an area.
- **Distance from Disturbances** -- weed species often spread as a result of disturbance in the area, such as wildfire or controlled burn areas, roads, trails, pipeline construction or oil and gas development. In fact, some species will spread only because of disturbance in the area.

LEVEL OF RISK

To assist with the following Forest Service project risk assessment protocol, the following weed susceptibility assessment may be helpful in determining the level of risk depending upon the environmental setting and invasiveness of the weed.

APPENDIX D
PREVENTION
PROJECT RISK ASSESSMENTS AND BEST MANAGEMENT PRACTICES

A risk assessment was completed for several weeds occurring in the USFS Northern Region, East of the Continental Divide (http://www.fs.fed.us/r1/cohesive_strategy/datafr.htm). Data, literature sources, and expert opinion were used to determine if a species could become established in each potential natural vegetation type. Expert opinion came from a panel of botanists and ecologists who were convened to review the findings from data and literature.

The risk assessment used a three-tiered approach to access risk to native plant communities from exotic plant species. The attached species specific matrix can be used to help assess the project area's susceptibility and level of threat for spread. The susceptibility of areas to species' establishment, the level of threat to susceptible areas, and the probability of exposure of each site to plant propagules affecting dispersal can be determined. Native plant communities are represented by various biophysical settings and modeled as 34 potential natural vegetation groups. Susceptibility, threat, and probability of exposure can be combined to model the degree of risk across a project area from some of the most threatening exotic species. Proposed disturbance information can be combined with potential natural vegetation (PNV) data to identify which areas are susceptible to each exotic plant species analyzed.

Susceptibility refers to the vulnerability of a native plant community to colonization and establishment of an exotic species. Susceptibility is rated using a categorical system where each combination of a species and PNV is coded with one of the following:

- **U – Unknown:** Susceptibility of this PNV to the species is unknown
- **C – Closed:** The species generally does not occur within this PNV under any condition
- **I – Invasive:** The species is invasive in undisturbed conditions within this PNV. If a species is rated as "I", the assumption is that it would also invade with disturbance.
- **D – Disturbance:** The species occurs in this PNV where there has been evidence of recent disturbance.

Threat refers to the degree of change to the structure, composition, or function of a native community from an exotic species. Threat is displayed using a qualitative ranking of three classes: low, high, and none. Factors taken into consideration for classifying threat are as follows:

- **L – Low Threat:** Species can become established; however, they cannot compete well with native vegetation, even in disturbed settings. Species with low threat never increase substantially in cover without the aid of severe site disturbance. Even in cases of moderate to mild disturbance events (e.g. low intensity fires, moderate grazing) native plants still are able to compete successfully.
- **H – High Threat**: Species are rated as having high threat if once established they can compete successfully with native vegetation. These changes would have to be significant enough to where the function of the plant community is substantially altered. These changes would include alteration in natural pathways of succession, a change in the natural fire regime, and/or significant changes to the composition and canopy cover of native plant species.
- **N – No Threat:** A species can only be assigned no threat to a PNV if it is closed (C) to that PNV.
- **U – Threat Unknown**

Probability of exposure / transport can be assessed by combining various factors that are considered to be influential on the probability that the particular area would be exposed to seeds of the species being evaluated. Factors include, but are not limited to, distance to nearest population of known species occurrence; road density classes; distance to primary/secondary federal or state highway or other high use road systems; distance to and level of other spread vectors. The exposure / transport factors added together, and based upon the final value, can give a probability of exposure rating of low, moderate, or high.

Risk: Data from the three input sources (susceptibility, threat, and exposure) can be used with the following rule set to determine the level of risk to a site from each species.

Susceptibility	Threat	Exposure	= Risk
Not susceptible	None	Any level	No risk
Susceptible	Low	Any level	Low
Susceptible	Unknown	Any level	Unknown
Susceptible	High	Low	Moderate
Susceptible	High	Moderate	High
Susceptible	High	High	High
Unknown	Unknown	Any level	Unknown

SUSCEPTIBILITY / THREATS MATRIX, USFS NORTHERN REGION EAST OF THE CONTINENTAL DIVIDE

Species	Rocky Mtn Juniper	Limber Pine	Ponderosa Pine	Lodgepole	Douglas-fir 1	Douglas-fir 2w	Douglas-fir 3w	Spruce	Subalpine Fir 1e	Subalpine Fir 2e	Whitebark Pine	rc_xeric	Riparian grass - wet	Riparian grass - dry	Riparian shrub	Riparian deciduous
Russian knapweed	U ?	U ?	D H	C N	D H	C N	C N	C N	C N	C N	C N	D ?	D H	D H	D H	D H
Japanese brome	IL	IL	IL	C N	IL	D L	C N	C N	C N	C N	C N	IL	C N	C N	C N	IL
downy brome	IL	IL	I H	C N	I H	D L	C N	C N	C N	C N	C N	IL	C N	D L	C N	IL
hoary cress (whitetop)	C N	U ?	U ?	U ?	U ?	U ?	U ?	U ?	U ?	C N	C N	U ?	C N	D H	D L	U ?
spotted knapweed	I H	I H	I H	D L	I H	D L	D L	D L	D L	D L	C N	I H	C N	D L	D L	D H
diffuse knapweed	I H	U ?	D H	U ?	D H	D H	D H	C N	C N	C N	C N	D H	C N	C N	D L	D L
yellow starthistle	U ?	U ?	D H	C N	D L	C N	D L	C N	C N	C N	C N	D H	C N	C N	C N	C N
rush skeletonweed	U ?	U ?	D H	D L	D ?	D L	D L	D L	D L	D L	C N	D L	U ?	U ?	D L	D L
oxeye daisy																
Canada thistle	C N	D L	D L	D L	D L	D L	D L	D L	D L	D L	D L	D L	C N	D H	D H	D L
field bindweed																
common crupina	U ?	U ?	D H	C N	D L	U ?	U ?	C N	C N	C N	C N	U ?	C N	C N	C N	C N
houndstongue	U ?	D L	D ?	U ?	IL	D L	D ?	D ?	D L	C N	C N	U ?	C N	D H	D H	IL
common teasel	U ?	U ?	D L	C N	D L	D L	U ?	C N	C N	C N	C N	U ?	D L	D H	D L	U ?
Russian olive	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	I?	I H	I H	I H	I H
quackgrass	C N	C N	C N	D L	D L	D L	D L	D L	D L	C N	C N	D H	D H	D H	D H	D H
leafy spurge	I H	I H	I H	C N	I H	D L	IL	D L	C N	C N	C N	I H	I H	I H	I H	I H
orange hawkweed	C N	C N	C N	D L	D L	D L	D ?	D H	D H	D H	U ?	U ?	C N	D H	D L	U ?
meadow hawkweed	U ?	U ?	D L	D L	D ?	D ?	D H	D H	D H	D H	C N	U ?	C N	I H	U ?	D ?
St. Johnswort	D	U	I	D	I	D	D	D	D	D	C	D	D	D	D	D

Species	Aspen	Green Ash	androp	Dry grass	Idaho fescue	Western wheatgrass	Salt shrub	Skunkbush	Dry shrub	Shrubby cinquefoil	Big sagebrush	Alpine	Water	Mesic shrub e	rc_sub	rc_mes	Rock
Russian knapweed	U ?	U ?	U ?	D H	D ?	D H	U ?	U ?	D ?	U ?	D L	C N	C N	D H	C N	C N	C N
Japanese brome	D L	D L	IL	IL & D H	IL & D H	IL	IL	IL	IL	C N	IL	C N	C N	D L	C N	C N	C N
downy brome	D L	D L	IL	I H	I H	IL	IL	IL	I H	C N	IL	C N	C N	D L	C N	C N	C N
hoary cress (whitetop)	U ?	U ?	U ?	IL	D L	I H	IL	U ?	D L	D L	D H	C N	U ?	U ?	U ?	U ?	C N
spotted knapweed	D H	IL	I H	I H	I H	I H	I H	I H	I H	I H	I H	C N	C N	I H	D L	D L	C N
diffuse knapweed	U ?	U ?	U ?	I H	D H	U ?	U ?	I H	I H	U ?	D H	C N	C N	U ?	C N	C N	C N
yellow starthistle	U ?	U ?	U ?	I H	I H	U ?	U ?	U ?	I H	C N	IL & D H	C N	C N	D L	C N	C N	C N
rush skeletonweed	D ?	U ?	U ?	D H	D H	U ?	U ?	U ?	D H	U ?	D H	C N	C N	U ?	D L	D L	C N
oxeye daisy																	
Canada thistle	D H	D L	D L	C N	D L	D L	U ?	C N	D L	D L	D L	D L	C N	D H	D L	D L	C N
field bindweed																	
common crupina	C N	U ?	U ?	D L	D H	U ?	U ?	U ?	D L	U ?	D L	C N	C N	U ?	C N	C N	C N
houndstongue	D L	U ?	U ?	D L	D L	D L	C N	U ?	C N	D L	D L	C N	C N	IL	U ?	U ?	C N
common teasel	U ?	U ?	U ?	D L	D L	C N	U ?	U ?	C N	U ?	U ?	C N	C N	U ?	C N	D L	C N
Russian olive	C N	I H	C N	C N	C N	C N	IL	C N	C N	U ?	C N	C N	C N	U ?	C N	C N	C N
quackgrass	D H	D L	C N	C N	D L	D H	D L	C N	D L	D L	D L	C N	C N	D L	D L	D L	C N
leafy spurge	I H	I H	I H	I H	I H	I H	U ?	I H	I H	I H	I H	C N	C N	I H	C N	D L	C N
orange hawkweed	D H	U ?	U ?	C N	C N	C N	C N	C N	C N	U ?	C N	U ?	C N	U ?	D H	D H	C N
meadow hawkweed	U ?	U ?	U ?	I?	IL	U ?	U ?	U ?	U ?	U ?	U ?	C N	C N	U ?	D H	D H	C N
St. Johnswort	D	U	U	I	I	U	U	U	D	U	D	C	C	U	D	D	C

APPENDIX D
PREVENTION
PROJECT RISK ASSESSMENTS AND BEST MANAGEMENT PRACTICES

Species	Rocky Mtn Juniper	Limber Pine	Ponderosa Pine	Lodgepole	Douglas-fir 1	Douglas-fir 2w	Douglas-fir 3w	Spruce	Subalpine Fir 1e	Subalpine Fir 2e	Whitebark Pine	rc_xeric	Riparian grass - wet	Riparian grass - dry	Riparian shrub	Riparian deciduous	Aspen	Green Ash	androp	Dry grass	Idaho fescue	Western wheatgrass	Salt shrub	Skunkbush	Dry shrub	Shrubby cinquefoil	Big sagebrush	Alpine	Water	Mesic shrub e	rc_sub	rc_mes	Rock
	L	?	H	L	H	L	L	L	L	L	N	L	L	L	L	L	L	?	?	H	H	?	?	?	L	?	L	N	N	?	L	L	N
dyer's woad	U ?	I H	I H	D ?	I H	C N	U ?	C N	C N	C N	C N	I H	C N	D ?	D ?	D ?	D ?	D ?	U ?	I H	I H	U ?	U ?	U ?	I H	U ?	I H	C N	C N	D ?	C N	C N	C N
bluebuttons	U ?	U ?	U ?	U ?	U ?	U ?	U ?	U ?	U ?	U ?	U ?	U ?	C N	D H	U ?	U ?	I H	U ?	U ?	U ?	D H	U ?	U ?	U ?	U ?	U ?	I H	U ?	U ?	U ?	U ?	U ?	C N
perennial pepperweed	C N	U ?	C N	C N	C N	C N	C N	C N	C N	C N	C N	D H	D H	D H	D H	D ?	D ?	U ?	U ?	U ?	U ?	U ?	D ?	U ?	C N	U ?	U ?	C N	C N	U ?	C N	U ?	C N
Dalmatian toadflax	I H	I H	I H	D L	IL	D L	D L	C N	C N	C N	C N	U ?	U ?	U ?	D ?	D ?	U ?	U ?	U ?	I H	I H	U ?	U ?	I H	I H	I H	I H	C N	C N	U ?	C N	D L	C N
common toadflax	IL & D H	IL & D H	IL & D H	I H	IL & D H	D L	D L	D L	D L	D L	D L	IL & D H	C N	D H	D L	D L	D L	U ?	U ?	U ?	IL & D H	U ?	U ?	U ?	D L	D L	IL & D H	U ?	C N	D L	D L	D L	C N
purple loosestrife	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	I H	I H	I H	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	I H	C N	C N	C N	C N
yellow sweetclover	I H	IL	I H	C N	IL	D L	D L	C N	C N	C N	C N	IL	D L	D L	D L	IL	IL	IL	I H	I H	IL	I H	IL	IL	IL	D L	IL	C N	C N	D L	D L	D L	C N
water milfoil	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	I H	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	I H	C N	C N	C N	C N
reed canarygrass	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	I H	I H	I H	D H	U ?	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	I H	C N	D L	D L	C N
sulfur cinquefoil	U ?	I H	I H	D H	I H	D L	D L	D L	D L	C N	C N	I H	D L	D L	D L	D L	D L	U ?	U ?	I H	I H	U ?	C N	U ?	D H	U ?	IL	C N	C N	U ?	D L	D L	C N
tall buttercup	U ?	C N	C N	C N	C N	C N	C N	C N	C N	D L	C N	C N	I H	I H	D H	D ?	D ?	U ?	C N	C N	C N	U ?	C N	C N	C N	D ?	C N	U ?	C N	U ?	D L	D L	C N
perennial sowthistle	C N	C N	C N	C N	C N	C N	C N	U ?	C N	C N	C N	C N	D H	D H	D H	U ?	U ?	C N	C N	C N	C N	C N	C N	U ?	C N	D ?	C N	C N	C N	U ?	C N	U ?	C N
salt cedar, tamarisk	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	D H	D H	D H	D H	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N	C N
common tansy	U ?	C N	C N	D L	C N	D L	D L	D L	D L	D L	C N	D H	D H	D H	D H	D H	D L	U ?	C N	C N	C N	U ?	U ?	C N	C N	U ?	C N	C N	C N	U ?	D L	D L	C N

FOREST SERVICE PROJECT RISK ASSESSMENT PROTOCOL

Activities on National Forest System lands are to be evaluated for risk and level of risk to help project layout and design and project decisions. Once a Risk Assessment is completed, preventative measures (BMPs) can be developed and implemented to reduce the risk of introduction or spread of undesirable plants into the area. The following USFS Northern Region Risk Assessment Rating protocol should be used when evaluating risk of weed spread due to any activity being proposed on NFS managed lands. The following rating numbers are considered to be on a scale of 0-10.

FACTOR 1: Likelihood of Undesirable Plant Species, Including Noxious Weeds Species, Spreading to Project Area:

- **NONE (0):** Undesirable plants, including noxious weed species not located within or immediately adjacent to the project area. Project activity is not likely to result in the establishment of undesirable weed species on the project area.
- **LOW (1):** Undesirable plant species present in areas adjacent to but not within the project area. Project activities can be implemented and prevent the spread of undesirable plants into the project area.
- **MODERATE (5):** Undesirable plant species located immediately adjacent to or within the project area. Project activities are likely to result in some areas becoming infested with undesirable plant species even when preventative management actions are followed. Control measures are essential to prevent the spread of undesirable plants or noxious weeds within the project area.
- **HIGH (10):** Heavy infestations of undesirable plants are located within or immediately adjacent to the project area. Project activities, even with preventative management actions, are likely to result in the establishment and spread of undesirable plants on disturbed sites throughout much of the project area.

FACTOR 2: Consequence of Undesirable Plant Establishment in Project Area

- **LOW (1):** None. No cumulative effects expected.
- **MODERATE (5):** Possible adverse effects on site and possible expansion of infestation within project area. Cumulative effects on native plant community are likely, but limited.
- **HIGH (10):** Obvious adverse effects within the project area and probable expansion of undesirable plants, including noxious weed infestations to areas outside the project area. Adverse cumulative effects on native plant community are probable.

RISK RATING PROCEDURE

Step 1. Identify level of likelihood of adverse effects and assign values on a scale from 0-10 using the following as a guide:

- None: 0
- Low 1
- Moderate 5
- High 10

Step 2. Multiply level of likelihood times level of consequences.
Step 3. Use the value resulting in step 2 to determine Risk Rating and action as follows:

Value	Risk Rating	Action
0	NONE	Proceed as planned
1-10	LOW	Proceed as planned. Initiate control treatments on undesirable plant populations that get established in the area.
25	MODERATE	Develop and Implement preventative management measures for the proposed project to reduce the risk of introduction or spread of undesirable plants into the area. Monitor the area for at least three consecutive years and provide for control of new infestations.
50-100	HIGH	Modify project design and implement preventative management measures for the proposed project to reduce the risk of introduction or spread of undesirable plants into the area. Monitor the area for at least five consecutive years and provide for control of new infestations.

FOREST SERVICE BEST MANAGEMENT PRACTICES (BMPs)

This section is composed of Best Management Practices (BMPs) required by Northern Region Policy, required timber sale contracts, special use permits, and other special considerations for aquatic plant control. Best management practices are guides to use in planning resource management activities and operations. The guides assists manager and cooperators in identifying weed prevention practices that mitigate identified risks of weed introduction and spread for projects and programs. Factors critical in a prevention program include:

- Limiting weed seed dispersal occurring from vehicles and equipment traveling forest roads, and people and livestock traveling forest trails;
- Containing neighboring weed infestations;
- Minimizing soil disturbance;
- Detecting and eradicating newly established weeds;
- Establishing competitive desirable vegetation; and
- Managing forage, including re-vegetation and shade management.
- Limiting weed seed dispersal occurring from livestock feed.

Weed Seed Free Policy

The Weed Seed Free Feed and Straw program is a Forest and Region-wide requirement. This program requires all hay, straw and processed feeds entering the Forest to be certified free of weed seed. The certification program is controlled by the Montana and South Dakota State Departments of Agriculture and relies on a field survey of crops prior to harvest.

Northern Region - Forest Service Manual Policy

The following policy (FSM 2080, Supplement No.: R1 2000-2001-1) outlines Best Management Practices to be used as protection measures to various authorized activities on National Forest System lands in the Northern Region.

2080.4 - Responsibility.
Encourage weed awareness and education in employee development and training plans and orientation for both field and administrative work.

2080.43 - Forest Supervisor.
Forest Supervisors are responsible for:

1. Emphasizing weed awareness and weed prevention in all fire training, especially resource advisors, fire management teams, guard school, and district orientation.
2. Adding weed awareness and prevention education to Fire Effects and Prescribed Fire training.
3. Giving helicopter managers training in weed prevention and protection measures.
4. Resource Advisors should provide briefings to identify operational practices to reduce weed spread.
5. Providing Field Observers with weed identification aids and striving to avoid weed infestations in fire line location.

2080.44 - District Rangers.
District Rangers are responsible for:

1. Providing weed prevention briefings for helibase staff.
2. Ensuring at least one permanent staff member per District is trained and proficient in weed management.
3. Applying weed treatment and prevention on all Forest Service administrative sites including Ranger Stations, trailheads, campgrounds, pastures, interpretive and historic sites.

2081 – MANAGEMENT OF NOXIOUS WEEDS.
2081.2 - Prevention and Control Measures.

1. **Roads.**
   a. <u>**Required** Objectives and Associated Practices.</u>
      (1) Incorporate weed prevention into road layout, design, and alternative evaluation. Environmental analysis for road construction and reconstruction will include weed risk assessment.
      (2) Remove the seed source that could be picked up by passing vehicles and limit seed transport in new and reconstruction areas.
         (a) Remove all mud, dirt, and plant parts from all off road equipment before moving into project area. Cleaning must occur off National Forest lands. This does not apply to

service vehicles that will stay on the roadway, traveling frequently in and out of the project area.

(b) Clean all equipment prior to leaving the project site, if operating in areas infested with new invaders as determined by the Forest/District Weed Specialist. Reference Contract Provision C/CT 6.626.

(3) Re-establish vegetation on bare ground due to construction and reconstruction activity to minimize weed spread.

(a) Revegetate all disturbed soil, except the travel way on surfaced roads, in a manner that optimizes plant establishment for that specific site, unless ongoing disturbance at the site will prevent weed establishment. Use native material where appropriate and available. Use a seed mix that includes fast, early season species to provide quick, dense revegetation. To avoid weed contaminated seed, each lot must be tested by a certified seed laboratory against the all State noxious weed lists and documentation of the seed inspection test provided.

(b) Use local seeding guidelines for detailed procedures and appropriate mixes. Use native material where appropriate and available. Revegetation may include planting, seeding, fertilization, and weed-free mulching as indicated by local prescriptions.

(c) Monitor and evaluate success of revegetation in relation to project plan. Repeat as indicated by local prescriptions.

(4) Minimize the movement of existing and new weed species caused by moving infested gravel and fill material. The borrow pit will not be used if new invaders, defined by the Forest Weed Specialist, are found on site.

(5) Minimize sources of weed seed in areas not yet revegetated. If straw is used for road stabilization and erosion control, it must be certified weed-free or weed-seed free.

(6) Minimize roadside sources of weed seed that could be transported to other areas during maintenance.

(a) Look for priority weed species during road maintenance and report back to District Weed Specialist.

(b) Do not blade roads or pull ditches where new invaders are found.

(c) Maintain desirable roadside vegetation. If desirable vegetation is removed during blading or other ground disturbing activities, area must be revegetated according to section (3) (a), (b), (c) above.

(d) Remove all mud, dirt, and plant parts from all off road equipment before moving into project area. Cleaning must occur off National Forest lands. (This does not apply to service vehicles that will stay on the roadway, traveling frequently in and out of the project area.)

(e) Clean all equipment prior to leaving the project site, if operating in areas infested with new invaders, as determined by the Forest Weed Specialist. Reference Contract Provision C/CT 6.626.

(f) Straw used for road stabilization and erosion control will be certified weed-free or weed-seed-free.

(7) Reduce weed establishment in road obliteration/reclamation projects. Revegetate according to section (3) (a), (b), (c) above.

b. **Recommended** Objectives and Associated Practices.

(1) Retain shade to suppress weeds. Consider minimizing the removal of trees and other roadside vegetation during construction, reconstruction, and maintenance, particularly on southerly aspects.

(2) Consider re-establishing vegetation on bare ground due to construction and reconstruction activity to minimize weed spread. Road maintenance programs should include scheduled fertilization to maintain vigor of competitive vegetation (3-year period suggested).

(3) Minimize the movement of existing and new weed species caused by moving infested gravel and fill material. All gravel and borrow sources should be inspected and approved before use and transport. The source will not be used if the weeds present at the pit are not found at the site of intended use. If weeds are present, they must be treated before transport and use.

(4) Minimize roadside sources of weed seed that could be transported to other areas. Weed infestations should be inventoried and scheduled for treatment.

(5) Ensure that weed prevention and related resource protection are considered in travel management. Consider weed risk and spread factors in travel plan (road closure) decisions.

(6) Reduce weed establishment in road obliteration/reclamation projects. Consider treating weeds in road obliteration and reclamation projects before roads are made undriveable. Monitor and retreat as indicated by local analysis and prescription.

(7) Evaluate and prioritize noxious weeds along existing Forest Service access roads leading to project area and treat as indicated by local analysis and prescriptions, before construction equipment moves into project area. New road construction must be revegetated as described in Weed Prevention measure, see Roads Required Objectives and Associated Practices section (3) (a), (b), (c) above.

2. Recreation, Wilderness, Roadless Areas.

a. <u>**Required** Objectives and Associated Practices.</u>

(1) Minimize transport and establishment of weeds on National Forest Service lands.

(a) Include environmental analysis for recreation and trail projects in weed risk assessment.

(b) Post and enforce statewide weed-free feed orders.

(c) Seed only when necessary at backcountry sites to minimize introduction of nonnative species and weeds. Reseed according to Roads (3) (a), (b), (c) above.

(2) Reduce weed establishment and spread from activities covered by Recreation Special Use Permits.

(a) Include Clause R1-D4, (or subsequent approved direction), in all new and reissued recreation special use permits, authorizations, or other grants involving ground-disturbing activities. Include this provision in existing ground-disturbing authorizations, which are being amended for other reasons.

(b) Revegetate bare soil resulting from special use activity according to Roads (3) (a), (b), (c) above.

(3) Prevent weed establishment resulting from land and float trail use, construction, reconstruction and maintenance activities.

(a) Clean all equipment prior to leaving the project site, if operating in areas infested with new invaders (as determined by the Forest Weed Specialist).

b. <u>**Recommended** Objectives and Associated Practices.</u>

(1) Minimize transport and establishment of weeds on National Forest System (NFS) lands.

(a) Encourage backcountry pack and saddle stock users to feed only weed-free feed for several days prior to traveling off roads in the Forest. Before entering NFS land, animals should be brushed to remove any weed seed.

(b) Stock should be tied and/or held in the backcountry in such a way as to minimize soil disturbance and avoid loss of native/desirable vegetation.

(c) Maintain trailheads, boat launches, outfitter and public camps, airstrips, roads leading to trailheads, and other areas of concentrated public use in a weed-free condition.

(d) Motorized and/or mechanized (such as mountain bikes) trail users should inspect and clean their vehicles prior to using NFS lands.

(2) Consider reducing weed establishment and spread from activities covered by recreation, special use permits. Consider including Clause R1-D4, (or subsequent approved direction), by amending existing ground-disturbing authorizations as indicated by local prescriptions.

(3) Prevent weed establishment resulting from land and float trail use, construction, reconstruction, and maintenance activities.

(a) All trail crews should inspect, remove, and properly dispose of weed seed and plant parts found on their clothing and equipment.

(b) Inspect and approve all gravel and borrow sources before use and transport. The source will not be used if the weeds present at the pit are not found at the site of intended use. If weeds are present, they must be treated before transport and use.

3. Cultural Resources.

a. <u>**Required** Objectives and Associated Practices.</u> Reduce weed establishment and spread at archeological excavations.

(1) Revegetate bare soil resulting from cultural resource excavation activity according to the Roads (3) (a), (b), (c) section above.

4. Wildlife, Fisheries, and Botany.

a. <u>**Required** Objectives and Associated Practices</u>. Incorporate weed prevention into wildlife, fisheries, and botany project design.

(1). Include weed risk assessment in environmental analysis for wildlife, fish and botany projects with ground disturbing actions.

(2). Revegetate bare soil resulting from wildlife and fish project activity according to the Roads (3) (a), (b), (c) section above.

(0) Remove all mud, dirt, and plant parts from all off road equipment before moving into project area. Cleaning must occur off National Forest lands. (This does not apply to service vehicles that will stay on the roadway, traveling frequently in and out of the project area.)
(1) Clean all equipment prior to leaving the project site, if operating in areas infested with new invaders (as determined by the Forest Weed Specialist).

5. **Range**.

a. **Required** Objectives and Associated Practices.

(1) Ensure weed prevention and control is considered in management of all grazing allotments.
(a) Include weed risk assessment in environmental analysis for rangeland projects.
(b) When other plans do not already address noxious weeds, include practices and control measures in Annual Operating Plans.
(2) Minimize ground disturbance and bare soil.
(a) Revegetate, where applicable, bare soil from grazing activities according to the Roads (3) (a), (b), (c) section above.
(b) Check areas of concentrated livestock use for weed establishment and treat new infestations.
(3) Minimize transport of weed seed into and within allotments.
(a) Remove all mud, dirt, and plant parts from all off road equipment before moving into project area. Cleaning must occur off National Forest lands. (This does not apply to service vehicles that will stay on the roadway, traveling frequently in and out of the project area.)
(b) Clean all equipment prior to leaving the project site, if operating in areas infested with new invaders (as determined by the Forest Weed Specialist).
(c) Straw used for road stabilization and erosion control will be certified weed-free or weed-seed-free.

b. **Recommended** Objectives and Associated Practices.

(1) Transport of weed seed into and within allotments should be minimized.
(a) Avoid driving vehicles through off-road weed infestations.
(b) Feed certified weed-free feed to livestock for several days prior to moving them onto the allotment to reduce the introduction of new invaders and spread of existing weed species. Consider using transitional pastures when moving animals from weed infested areas to the National Forest. (Transitional pastures are designated fenced areas that can be logistically and economically maintained.)
(c) Consider excluding livestock from sites with new invaders or treat new invaders in these areas before entry by livestock.
(2) Maintain healthy desirable vegetation that is resistant to noxious weed establishment.
(a) Consider managing forage utilization to maintain the vigor of desirable plant species as described in the Allotment Management Plan.
(b) Minimize or exclude grazing on restoration areas until vegetation is well established.

6. **Timber**.

a. **Required** Objectives and Associated Practices.

(1) Ensure that weed prevention is considered in all pre-harvest timber projects.
(a) Include weed risk assessment in environmental analysis for timber harvest projects.
(b) Remove all mud, dirt, and plant parts from all off road equipment before moving into project area. Cleaning must occur off National Forest lands. (This does not apply to service vehicles that will stay on the roadway, traveling frequently in and out of the project area.) Reference Contract Provision C/CT6.26
(c) Clean all equipment prior to leaving the project site, if operating in areas infested with new invaders (as designated by the Forest Weed Specialist). Reference Contract Provision C/CT6.261
(2) Minimize the creation of sites suitable for weed establishment. Revegetate bare soil as described in the Roads (3) (a), (b), (c) section above.

b. **Recommended** Objectives and Associated Practices.

(1) Ensure that weed prevention is considered in all timber projects.
(a) Consider treating weeds on roads used by timber sale purchasers. Reference Contract Provision C/CT6.26.
(b) Treat weeds on landings, skid trails and helibases that are weed infested before logging activities, where practical.
(2) Minimize the creation of sites suitable for weed establishment. Soil disturbance should be minimized to meet harvest project objectives.

(3) Consider monitoring for weeds after sale activity and treat weeds as indicated by local prescriptions.
   (a) Consider trust, stewardship, or other funds to treat soil disturbance or weeds as needed after timber harvest and regeneration activities.
   (b) Consider monitoring and treating weed infestations at landings and on skid trails after harvest.

7. **Minerals.**

a. <u>**Required** Objectives and Associated Practices.</u>

(1) Minimize weed establishment in mining, oil and gas operations, and reclamation.
   (a) Include weed risk assessment in environmental analysis for minerals and oil and gas projects.
   (b) Include weed prevention measures in operation and/or reclamation plans.
   (c) Retain bonds until reclamation requirements are completed.
   (d) Revegetate bare soil as described in the Roads (3) (a), (b), (c) section above.

(2) Remove seed source and limit seed transport into new or existing mining and oil and gas operations. Remove all mud, dirt, and plant parts from all off road equipment before moving into project area. Cleaning must occur off National Forest lands. (This does not apply to service vehicles that will stay on the roadway, traveling frequently in and out of the project area.)

(3) Minimize weed spread caused by moving infested gravel and fill material.
   (a) The borrow pit will not be used if new invaders (as defined by the Forest Weed Specialist) are found on the site.
   (b) Remove all mud, dirt, and plant parts from all off road equipment before moving into project area. Cleaning must occur off National Forest lands. (This does not apply to service vehicles that will stay on the roadway, traveling frequently in and out of the project area.)
   (c) Do not establish new gravel and fill material sources in areas where new invaders are present on National Forest Service lands. Where widespread weeds occur at new pit sites strip at least the top 8" and stockpile contaminated material. Treat weeds at new pits where widespread weeds are present.

b. <u>**Recommended** Objectives and Associated Practices.</u>

(1) Consider removing seed source and limiting seed transport into new or existing mining and oil and gas operations. Where applicable, treat weeds on project access routes. Reference Contract Provision C/CT6.27.

(2) Minimize weed spread caused by moving infested gravel and fill material.
   (a) Inspect and approve all gravel and borrow sources before use and transport. The source should not be used if the weeds present at the pit are not found at the site of intended use. If weeds are present, they should be treated before transport and use.
   (b) Consider maintaining stockpiled material in a weed-free condition.
   (c) Check the area where pit material is used to ensure that no weed seeds are transported to the use site.

8. **Soil and Water.**

a. <u>**Required** Objectives and Associated Practices.</u>

(1) It is required that integrated weed prevention and management be used in all soil, watershed, and stream restoration projects.
   (a) Include weed risk assessment in environmental analysis for soil, watershed, and stream restoration projects with ground disturbing actions.
   (b) Revegetate bare soil resulting from excavation activity according to the Roads (3) (a), (b), (c) section above.
   (c) Remove all mud, dirt, and plant parts from all off road equipment before moving into project area. Cleaning must occur off National Forest lands. (This does not apply to service vehicles that will stay on the roadway, traveling frequently in and out of the project area.)
   (d) Clean all equipment prior to leaving the project site, if operation in areas infested with new invaders (as designated by the Forest Weed Specialist).
   (e) Straw used for road stabilization and erosion control will be certified weed-free or weed-seed-free.

b. <u>**Recommended** Objectives and Associated Practices.</u>

(2) Integrate weed prevention and management in all soil, watershed, and stream restoration projects by considering treating weeds in road obliteration and reclamation projects before roads are made undriveable. Monitor and retreat as indicated by local prescriptions.

9. Lands and Special Uses.

a. **Required** Objectives and Associated Practices.

(1) Incorporate weed prevention provisons in all special use permits, road use permits, and easements.

(a) Include weed risk assessment in environmental analysis for land projects with ground disturbing actions.

(b) Revegetate bare soil as described in the Roads (3) (a), (b), (c) section above, as a condition of the authorization.

(c) Include approved special use provision R1-D4, see FSH 2709.11, chapter 50, (or subsequent approved direction) in all new and reissued special use permits, authorizations, or other grants involving ground disturbing activities. Include this provision in existing ground disturbing authorizations, which are being amended for other reasons .

(d) Include noxious weed prevention and control measures as indicated by local prescriptions in new or reissued road permits or easements granted pursuant to FLPMA (P.L. 94579 0/2/76), FRTA (P.L. 88657 0/3/64) or subsequent authorities. This includes FLPMA Private and Forest Road Permits and Easements; FRTA Private and Forest Road Easements; Cost Share Easements; and Road Use (commercial haul) Permits (7730). (While the approved terms and conditions of certain permits or easements may not provide for modification, the necessary weed prevention and control provisions may be included in written plans, specifications, stipulations and /or operation and maintenance plans attached to and made a part of the authorization.)

(e) Clean all equipment prior to leaving the project site, if operating in areas infested with New Invaders (as designated by the Forest Weed Specialist).

(2) Minimize weed spread caused by moving infested gravel and fill material.

(a) Do not establish new gravel and fill material sources on National Forest Service lands in areas where new invaders are present. Where widespread weeds occur at new pit sites strip at least the top 8" and stockpile contaminated material. Treat weeds at new pits where widespread weeds are present.

(b) Remove all mud, dirt, and plant parts from all off-road equipment before moving into project area. Cleaning must occur off National Forest lands. (This does not apply to service vehicles that will stay on the roadway, traveling frequently in and out of the project area.)

b. **Recommended** Objectives and Associated Practices.

(1) Incorporate weed prevention provisions in all special use permits, road use permits and easements.

(a) Consider including special use provision R1-D4 by amending existing ground disturbing authorizations as indicated by local prescriptions.

(b) Consider including noxious weed prevention and control provisions by amending existing ground disturbing authorizations when determined to be necessary by the authorized officer. (While the approved terms and conditions of certain permits or easements may not provide for modification, the necessary weed prevention and control provisions may be included in written plans, specifications, stipulations and/or operation and maintenance plans attached to and made a part of the authorization.)

(2) Minimize weed spread caused by moving infested gravel and fill material. All gravel and borrow sources should be inspected and approved before use and transport. The source should not be used if the weeds present at the pit are not found at the site of intended use. If weeds are present, they should be treated before transport and use.

10. Fire.

a. **Required** Objectives and Associated Practices.

(1) Increase weed awareness among all fire personnel. Include weed risk factors and weed prevention considerations in the Resource Advisor duties on all Incident Management Teams and Fire Rehabilitation Teams during pre-fire, pre-incident training.

(2) Mitigate and reduce weed spread during wild fire activities

(a) Initiate establishment of a network of helibases, camps and staging areas that will be maintained in a noxious weed-free condition.

- (b) Minimize weed spread in camps by incorporating weed prevention and containment practices such as mowing, flagging or fencing weed patches, designating weed-free travel routes and washing equipment.
- (c) Inspect all fire going vehicles regularly to assure that undercarriages and grill works are kept weed seed free. All vehicles sent off Forest for fire assistance will be cleaned before they leave or return to their home.

(3) Minimize weed spread during smoke jumper operations.
- (a) Inspect, remove, and properly dispose of weed seed and plant parts found on clothing and equipment.
- (b) Coordinate with Weed Specialist(s) to locate and/or treat practice jump areas.

(4) Mitigate and reduce weed spread in Air Operations.
- (a) Initiate establishment of a network of helibases that will be maintained in a noxious weed-free condition.
- (b) Minimize weed spread at helibases by incorporating weed prevention and containment practices such as mowing, flagging or fencing weed patches, designating weed-free travel routes.
- (c) Provide weed prevention briefings for helibase staff.
- (d) Inspect, and if necessary clean, contract fuel and support vehicles before and after each incident when travelling off road or through weed infestations.
- (e) Inspect and remove weed seed and plant parts from all cargo nets.

(5) Mitigate and reduce weed spread from Logistics Operations activities.
- (a) Look for weed-free camps, staging, drop points and parking areas.
- (b) Regularly inspect and clean fire vehicles as necessary to assure that undercarriages and grill works are kept weed seed free.

(6) Integrate weed prevention and management in all prescribed burning. Mitigate and reduce weed spread during prescribed fire activities.
- (a) Include weed risk assessment in environmental analysis for prescribed fire projects.
- (b) Coordinate with local Noxious Weed Management Specialist to utilize helibases that are maintained in a weed-free condition, whenever possible.
- (c) All crews should inspect, remove, and properly dispose of weed seed and plant parts found on their clothing and equipment.
- (d) Add weed awareness and prevention education to Fire Effects and Prescribed Fire training.

(7) Encourage desirable vegetation during rehabilitation activities.
- (a) Revegetate only erosion susceptible and high risk areas (as defined in Regional Risk Assessment Factors and Rating protocol) as described in the Roads (3) (a), (b), (c) section above.
- (b) Straw used for road stabilization and erosion control will be certified weed-free or weed-seed-free.

b. <u>**Recommended** Objectives and Associated Practices.</u>

(1) Mitigate and reduce weed spread during fire activities.
- (a) Initiate establishment of a network of helibases, camps, and staging areas on private land that will be maintained in a noxious weed-free condition.
- (b) Consider checking and treating weeds that establish at cleaning sites after fire incidents, during rehabilitation.
- (c) Emphasize Minimum Impact Suppression Tactics (M.I.S.T.) to reduce soil and vegetation disturbance.

(2) Minimize weed spread during smokejumper operations. Travel through weed infested areas should be avoided or minimized.

(3) Mitigate and reduced weed spread from Logistics Operations activities. Traffic should be routed through camps to avoid weed infested areas.

(4) Integrate weed prevention and management in all prescribed burning. Mitigate and reduce weed spread during prescribed fire activities.
- (a) Consider treating high risk areas (as defined in Regional Risk Assessment Factors and Rating protocol) with weed infestations (such as roads, disturbed ground) before burning and check and retreat after burning if necessary.
- (b) Consider avoiding ignition and burning in high risk areas (as defined in Regional Risk Assessment Factors and Rating protocol) that cannot be treated before or after prescribed fire.

(5) Encourage desirable vegetation during rehabilitation activities.
- (a) Check and treat weeds at cleaning sites and all disturbed staging areas.

(b) Treat weeds within the burned area as part of rehabilitation plan to reduce weed spread.
(c) Check weed spread resulting from fire and fire suppression activities.
(d) Consider applying for restoration funding for treatment of weed infestations within the fire area.

11. Administration.

a. **Required** Objectives and Associated Practices.
   (1) Ensure all Forest Service employees are aware of and knowledgeable about noxious weeds.
      (a) Train Line Officers in noxious weed management principles and practices.
      (b) Each unit will have access to Weed Specialist at the Ranger District or Supervisor's Office.
   (2) Ensure all Forest workers are reducing the chance of spreading noxious weeds. All Forest workers will inspect, remove, and properly dispose of weed seed and plant parts found on their clothing and equipment including Forest Service vehicles.

b. **Recommended** Objectives and Associated Practices.
   (1) Consider a reward program for weed awareness, reporting, and beating new invaders.

2082 - COOPERATION.

1. **Required** Objectives and Associated Practices. Coordinate road maintenance activities with herbicide applications to maximize efficacy. Ensure road blading and roadside herbicide applications are coordinated chronologically to minimize herbicide use and increase effectiveness.

2. **Recommended** Objectives and Associated Practices. Consider providing Plans Section with weed control contact familiar with weeds in the fire area.

2082.2 - Methods of Cooperation.

1. **Required** Objectives and Associated Practices.
   a. Reduce weed establishment and spread at archeological excavations. Passports In Time programs and other Cultural Resource workers shall be given weed briefings and will inspect, remove, and properly dispose of weed seed and plant parts found on their clothing and equipment.
   b. Promote weed awareness and prevention efforts among range permittees. Discuss weed awareness and prevention practices at annual permittee meetings.

Riparian and Aquatic Herbicide Use

Generally, the use of herbicides near waterways for weed control should be minimized and therefore it is important to consider other integrated pest management techniques that can be alternatives to, or complementary with, herbicides. However, for some weeds such as purple loosestrife, salt cedar, or Eurasian watermilfoil, aquatic herbicide treatment may be necessary. When used correctly, herbicides can be very effective and have limited impact on the environment. Appendix C - Protection Measures outline herbicide restrictions and limitations, including vegetative buffers and setbacks in riparian and aquatic settings.

The risk of waterway contamination or unwanted effects resulting from registered herbicide use in riparian or aquatic situations can be reduced by following a simple checklist below These general practices presented in the checklist are in addition to and not a replacement for, label directions and the pertinent codes of practice relating to chemical application. Always seek site-specific advice if you are unsure of herbicide impacts on both the target weed and any non-target species (flora and fauna).

- If possible suppress targeted aquatic weeds by restricting light and nutrients.
- Assess the risk to non-target organisms based on herbicide mobility, persistence and toxicity.
- Provide contractors with a map showing the location of waterways and associated soaks and drains.
- Avoid treating dense beds of submerged weeds in a single application as this may cause de-oxygenation when they rot.
- Weeds overhanging a waterway or growing within the channel should be treated as an aquatic situation.
- Spray when heavy rain is not expected for some time (a minimum of several days).
- Choose the application method that minimizes the amount of herbicide used and its dispersal.
- If spraying towards a waterway clearly mark the edge beforehand.
- Ensure that equipment is properly maintained, adjusted and not leaking.
- Around waterways carry herbicide only in secure containers.
- Only add surfactants to herbicides registered for aquatic use if they are specified on the label.
- Mix chemicals and rinse equipment well away from the waterway.
- Direct herbicide spray away from the waterway if at all possible.
- Apply the minimum amount of spray required to achieve the degree of wetting specified on the label.
- Move upstream when spraying to maximize dilution.

Pit and Stockpile Guidelines - Aggregate and Borrow Material

The following noxious weed management guidelines clarify best management practices related to pit or stockpile sources for aggregate and borrow material requirements and recommendations outlined in FSM 2080, Supplement No.: R1 2000-2001-1, subpart 2081.2 - Prevention and Control Measures, item 1, Roads and item 7, Minerals.

The following protocol should be used for all pits or stockpiles in which aggregate and borrow material will be used on Custer National Forest managed lands[1]. On right-of-ways where intermingled road jurisdiction occurs, coordination with appropriate counties or other management agencies (i.e. Montana or South Dakota Departments of Transportation, FHA, etc.) may be needed to recommend these best management practices be used.

Inspection Guidelines for Pit or Stockpiles with Weeds

Depending upon the length of use of pit material, one to two inspections of the pit or stockpile during the summer growing season should be conducted[2]. Inspection protocols include:

- Coordinate and identify pits/stockpiles to be surveyed with appropriate individuals.
- Obtain basic pit/stockpile information relative to location, ownership, and where the material is being proposed for use.
- Contact pit/stockpile landowner or operator to arrange inspection.
- Conduct windshield inspection of overall pit/stockpile area (active and inactive portions of the site).
- Conduct a walking inspection of the active operations area and transport routes.
- Photograph stockpile or pit operations and designated noxious weed infestations.
- List designated noxious weeds found, location, and number.
- Map designated noxious weed infestation locations relative to the pit/stockpile active operations area and transport routes.
- Discuss the inspection results with the landowner or operator.
- Submit documented inspection to the appropriate project manager on the Forest and to the owner/operator.
- The project manager should maintain pit / stockpile specific files including the weed management plan, basic information, inspection, photographs, map, etc.
- The owner/operator or contractor can have a qualified weed expert, such as a county extension agent or county weed supervisor, use this inpection protocol and submit pit or stockpile inspection documentation for Forest Service approval.

Types of Approved Pits or Stockpiles. The following types of pits or stockpiles are approved sources for aggregate and borrow material to be used on Custer National Forest managed lands.

- ***Weed Free Approved Pit or Stockpile.*** No Montana, Wyoming, South Dakota, or North Dakota designated noxious weeds (including county designated noxious weeds) are permitted to produce seeds in the active operations area[3]. This type of pit or stockpile will only be approved for up to one year at a time, pending growing conditions and the possible need for more than one inspection.

- ***Conditionally Approved Pit or Stockpile.*** A maximum of two MT/WY/SD/ND designated noxious weed species (including county designated noxious weeds) with a total of less than ten weeds (plants) are permitted to produce seeds in the **active operations area** (mining, crushing, loading, material source, equipment storage or within 20 feet of road shoulders). All topsoil, overburden, and other materials (six inch depth minimum) within 10 feet of all designated noxious weeds in the active pit area which may contain viable weed seeds shall be moved to an inactive area of the pit for storage and future treatment.

  In addition, less than 100 total weeds (plants) consisting of a maximum of two MT/WY/SD/ND designated noxious weeds (including county designated noxious weeds) produced seed in the **inactive pit or stockpile areas** such as overburden piles, reject piles, and pit periphery involving no traffic. No new invaders to the area are noted. Pits or stockpiles will only be conditionally approved for up to one year, pending growing conditions and the possible need for more than one inspection.

- ***Heat Treated Approved Pit or Stockpile.*** Due to unacceptable type(s) of species or amount of designated noxious weed infestations in the pit or stockpile, all material must be heat treated to 300 degrees Fahrenheit and transported from the pit within 7 days of heat treating.

---

[1] Adapted from the Greater Yellowstone Weed Coordinating Committee Gravel Pit Guidelines. 2006
[2] Two inspections may be needed in high moisture years and / or in areas where noxious weed species are known to germinate periodically throughout the growing season (i.e. spotted knapweed) or are abundant enough in adjacent areas where more viable seeds have a higher probability of occurring.
[3] This would include new non-native species to the area known to be highly invasive in other areas of the country.

Best Management Practices Soil and Water Conservation Practices (FSH 2509.22)

The following BMPs for this project were selected from the Soil and Water Conservation Handbook (2509.22). Application of the BMPs will ensure compliance with the requirements of the Federal Water Pollution Control Act.

13.08: Pesticide Application According to Label Directions and Applicable Legal Requirements – All approved herbicides will be applied according to label instructions to avoid water contamination. Directions found on the label of each herbicide are detailed and specific, and include legal requirements for use. These constraints will be incorporated into the individual project plans and contracts. Responsibility for in-service projects rests with the Forest Service's project supervisor who shall be a certified applicator. For contracted projects, it is the responsibility of the contracting officer or the contracting officer's representative to ensure that label instructions and other applicable legal requirements are followed.

13.09: Pesticide Application Monitoring and Evaluation – The objective of this BMP is to determine whether pesticides were applied safely, restricted to intended target areas, and deposited at the right rates. It is also designed to evaluate if non-target species were impacted. Another component is also to provide early warning of possible hazardous conditions and determine the extent, severity, and duration of any potential hazard that might exist. Monitoring methods include spray cards, dye tracing, and direct measurements of herbicides on plants or near water. Monitoring of existing herbicide concentrations will be conducted prior to any treatments in riparian corridors where perennial water is found.

13.10: Pesticide Spill Contingency Plan – The objective of this BMP is to eliminate contamination of water or the soil resource that may occur from accidental spills. The spill plan is found in Appendix M.

13.11: Cleaning and Disposal of Herbicide Containers – This BMP is designed to prevent water contamination from cleaning or disposal of herbicide containers. The cleaning and disposal of these items will be done in accordance with Federal, State, and local laws. The forest or district pesticide use coordinator will approve proper rinsing procedures in accordance with State and local laws and regulations, and arrange disposal of containers when in-service personnel apply the product. When a contractor applies the herbicide, the contractor is responsible for proper container disposal in accordance with label instructions.

13.12: Protection of Water, Wetlands, and Riparian Areas During Pesticide Spraying.
The objective of this BMP is to minimize the risk of pesticide entering surface or subsurface waters or affecting riparian areas, wetlands, and other non-target areas. Untreated buffer strips will be left alongside surface waters, wetlands and riparian areas. Protection of untreated areas is the responsibility of Forest Service project supervisor for In-service projects and the COR for contracted projects.

13.13: – Controlling Pesticide Drift During Spray Application – The objective of this BMP is to minimize risk of pesticides falling directly into water or non-target areas. The spray application of herbicides is accomplished according to a prescription which accounts for terrain, and that specifies the following: spray exclusion areas, buffer zones, and factors such as formulation, equipment, droplet size, spray height, application pattern, flow rate, and the limiting factors of wind speed and direction, temperature, and relative humidity. On in-service projects, the Forest Service project manager supervisor is responsible for ensuring the prescription is followed, whereas if contracted, the contracting officer is delegated the responsibility.

Forest Service Timber Sale Contract Provisions

The following are timber sale contract clauses intended to help prevent spread of weeds.

WO-C6.36

<u>C6.36</u> – <u>EQUIPMENT CLEANING</u>. (5/01) Unless the entire Sale Area is already infested with specific noxious weed species of concern, Purchaser shall ensure that prior to moving on to the Sale Area all off-road equipment, which last operated in areas known by Forest Service to be infested with specific noxious weeds of concern, is free of soil, seeds, vegetative matter, or other debris that could contain or hold seeds. Purchaser shall certify in writing that off-road equipment is free of noxious weeds prior to each start-up of timber sale operations and for subsequent moves of equipment to Sale Area. The certification shall indicate the measures taken to ensure that off-road equipment is free of noxious weeds will be identified. "Off-road equipment" includes all logging and construction machinery, except for log trucks, chip vans, service vehicles, water trucks, pickup trucks, cars, and similar vehicles. A current list of noxious weeds of concern to Forest Service is available at the Forest Supervisor's Office.

Purchaser must clean off-road equipment prior to moving between cutting units on this timber sale that are known to be infested with noxious weeds and other units, if any, that are free of such weeds. Sale Area Map shows areas, known by Forest Service prior to timber sale advertisement, that are infested with specific noxious weed species of concern.

Purchaser shall employ whatever cleaning methods are necessary to ensure that off-road equipment is free of noxious weeds. Equipment shall be considered free of soil, seeds, and other such debris when a visual inspection does not disclose such material. Disassembly of equipment components or specialized inspection tools is not required.

Purchaser shall notify Forest Service at least 5 days prior to moving each piece of off-road equipment on to the Sale Area, unless otherwise agreed. Notification will include identifying the location of the equipment's most recent operations. If the prior location of the off-road equipment cannot be identified, Forest Service may assume that it was infested with noxious weed seeds. Upon request of Forest Service, Purchaser must arrange for Forest Service to inspect each piece of off-road equipment prior to it being placed in service.

If Purchaser desires to clean off-road equipment on National Forest land, such as at the end of a project or prior to moving to a new unit that is free of noxious weeds, Purchaser and Forest Service shall agree on methods of cleaning, locations for the cleaning, and control of off-site impacts, if any.

New infestations of noxious weeds, of concern to Forest Service and identified by either Purchaser or Forest Service on the Sale Area, shall be promptly reported to the other party. Purchaser and Forest Service shall agree on treatment methods to reduce or stop the spread of noxious weeds when new infestations are found. In the event of contract modification under this Subsection, Purchaser shall be reimbursed for any additional protection required, provided that any work or extra protection required shall be subject to prior approval by Forest Service. Amount of reimbursement shall be determined by Forest Service and shall be in the form of a reduction in stumpage rates, unless agreed otherwise in writing. However, in no event may stumpage rates be reduced below Base Rates.

INSTRUCTIONS: Include in all new contracts.

The Forest Service must identify on the sale area map units that are infested with specific noxious weeds species of concern.

The prospectus for the sale must notify prospective purchasers that maps of these known locations are available from the local Forest Supervisor's Office or District Ranger Station. A list of noxious weeds of concern to the Forest Service (normally included in the Noxious Weed Program Guide) must be available for the purchaser's inspection. The current National Forest Noxious Weed Program Guide, noxious weed atlas, or other data sources, as needed, will be used to determine locations of known infestation.

Significant changes in the status of noxious weed infestations on the sale may require contract modifications to deal with changed conditions. An example might be where new noxious weed infestations are discovered after contract award, which require costly additional methods to prevent the spread of such infestations.

WO-CT6.36

CT6.36 – EQUIPMENT CLEANING. (5/01) Unless the entire Sale Area is already infested with specific noxious weed species of concern, Purchaser shall ensure that prior to moving on to the Sale Area all off-road equipment, which last operated in areas known by Forest Service to be infested with specific noxious weeds of concern, is free of soil, seeds, vegetative matter, or other debris that could contain or hold seeds. Purchaser shall certify in writing that off-road equipment is free of noxious weeds prior to each start-up of timber sale operations and for subsequent moves of equipment to Sale Area. The certification shall indicate the measures taken to ensure that off-road equipment is free of noxious weeds will be identified. "Off-road equipment" includes all logging and construction machinery, except for log trucks, chip vans, service vehicles, water trucks, pickup trucks, cars, and similar vehicles. A current list of noxious weeds of concern to Forest Service is available at the Forest Supervisor's Office.

Purchaser must clean off-road equipment prior to moving between cutting units on this timber sale that are known to be infested with noxious weeds and other units, if any, that are free of such weeds. Sale Area Map shows areas, known by Forest Service prior to timber sale advertisement, that are infested with specific noxious weed species of concern.

Purchaser shall employ whatever cleaning methods are necessary to ensure that off-road equipment is free of noxious weeds. Equipment shall be considered free of soil, seeds, and other such debris when a visual inspection does not disclose such material. Disassembly of equipment components or specialized inspection tools is not required.

Purchaser shall notify Forest Service at least 5 days prior to moving each piece of off-road equipment on to the Sale Area, unless otherwise agreed. Notification will include identifying the location of the equipment's most recent operations. If the prior location of the off-road equipment cannot be identified, Forest Service may assume that it was infested with noxious weed seeds. Upon request of Forest Service, Purchaser must arrange for Forest Service to inspect each piece of off-road equipment prior to it being placed in service.

If Purchaser desires to clean off-road equipment on National Forest land, such as at the end of a project or prior to moving to a new unit that is free of noxious weeds, Purchaser and Forest Service shall agree on methods of cleaning, locations for the cleaning, and control of off-site impacts, if any.

New infestations of noxious weeds, of concern to Forest Service and identified by either Purchaser or Forest Service on the Sale Area, shall be promptly reported to the other party. Purchaser and Forest Service shall agree on treatment methods to reduce or stop the spread of noxious weeds when new infestations are found. In the event of contract modification under this Subsection, Purchaser shall be reimbursed for any additional protection required, provided that any work or extra protection required shall be subject to prior approval by Forest Service. Amount of reimbursement shall be determined by Forest Service and shall be in the form of a reduction in stumpage rates, unless agreed otherwise in writing. However, in no event may stumpage rates be reduced below Base Rates.

INSTRUCTIONS: Include in all new contracts.

The Forest Service must identify on the sale area map units that are infested with specific noxious weeds species of concern.

The prospectus for the sale must notify prospective purchasers that maps of these known locations are available from the local Forest Supervisor's Office or District Ranger Station. A list of noxious weeds of concern to the Forest Service (normally included in the Noxious Weed Program Guide) must be available for the purchaser's inspection. The current National Forest Noxious Weed Program Guide, noxious weed atlas, or other data sources, as needed, will be used to determine locations of known infestation.

Significant changes in the status of noxious weed infestations on the sale may require contract modifications to deal with changed conditions. An example might be where new noxious weed infestations are discovered after contract award, which require costly additional methods to prevent the spread of such infestations.

Special Use Permit Supplemental Clause

Northern Region policy is to include a weed prevention and control provision, such as the following supplemental clause example, in all new special-use authorizations such as, permits, easements, and leases, or when those authorizations are amended, when there are ground-disturbing activities.

The following is a weed prevention and control supplemental clause approved for use in Region 1 (FSH 2709.11, 50 - R1 Supplement 2709.11-2000-1). Use this clause in all authorizations involving ground disturbance which could result in the introduction or spread of noxious weeds and/or exotic plants. This clause may also be used where cooperative agreements for noxious weed control are in place with state and local governments.

> *The holder shall be responsible for the prevention and control of noxious weeds and/or exotic plants of concern on the area authorized by this authorization and shall provide prevention and control measures prescribed by the Forest Service. Noxious weeds and exotic plants of concern are defined as those species recognized by* (insert county weed authority and/or national forest) *in which the authorized use is located.*
>
> *The holder shall also be responsible for prevention and control of noxious weed and exotic plant infestations which are not within the authorized area, but which are determined by the Forest Service to have originated within the authorized area.*
>
> *When determined to be necessary by the authorized officer, the holder shall develop a site-specific plan for noxious weed and exotic plant prevention and control. Such plan shall be subject to Forest Service approval. Upon Forest Service approval, the noxious weed and exotic plant prevention and control plan shall become a part of this authorization, and its provisions shall be enforceable under the terms of this authorization.*

With respect to the second paragraph of the above provision, the intent is to apply this provision only for a well defined confined area such as a narrow linear right-of-way where it can be determined without a doubt that the noxious weeds resulted from the activities of the holder.

APPENDIX E
TREATMENT PRIORITIES, ADAPTIVE MANAGEMENT, AND MINIMUM TOOL GUIDELINES

To help assess priorities for weed treatments, priority criteria have been established and should be followed (see Table E – 1). To quickly and effectively treat newly discovered weed infestations, a decision tree based on site characteristics, weed species, and location would be used to select treatment methods as part of an adaptive management strategy. As another part of the adaptive management strategy in order to improve effectiveness and reduce impacts, new technologies, biological controls, adjuvants, or herbicides could be evaluated for use (see Table E – 2). Minimum tool guidelines have been established For Wilderness Areas, Hiking Areas, or other Remote Areas with Difficult Access and should be followed (see Table E – 3). See Table E – 4 for risk assessment guidelines for use of riparian or aquatic herbicides.

TREATMENT PRIORITY CRITERIA

The following table depicts weed treatment priorities to be utilized on the Custer National Forest due to limited funding and treatment effectiveness aspects. Priority is generally given to those new populations of aggressive invader species where long-term management can be successful. An example would be a new site consisting of five plants of salt cedar. On larger, well established infestations, such as 200 acres of leafy spurge, where long term effectiveness is questionable, containment strategies play a much more important role. Even then, control emphasis is provided along the spread vector areas such as trailheads, roadways, campgrounds, and parking areas. Choice of treatment is based on site specific conditions.

TABLE E – 1. TREATMENT PRIORITY CRITERIA

Priority	Description	Treatment
Highest Priority for Treatment	• Eradication[1] of new species (focus on aggressive species with potential for significant ecological impact including but not limited to State listed high priority species – Category 3[2]) • New infestations (e.g. populations in areas not yet infested; "spot fires"; any State, County, and Forest-listed highest priority species – Category 2[3]). • Areas of concern such as: Areas of high traffic spread vectors and sources of infestation (e.g. parking lots, trailheads, roadsides, horse camps, gravel pits) • Areas of special concerns: (e.g. wilderness, research natural areas, big game winter ranges, adjacent boundaries/access with National Parks) Riparian corridors or Sensitive plant populations where there is a high threat to species of concern. • Areas where partnership / cooperator agreements are in place.	• Cultural/mechanical - isolated plants or small populations. • Herbicide treatment if manual/mechanical is known to be ineffective or population too large. • Remove seed heads. This is an interim measure if cost/staff is an issue.
Second Priority of Treatment	• Containment[4] of existing large infestations (e.g. focus on State, County, and Forest-listed highest priority species – Category 1[5]) – focus on boundaries of infestation. • Roadsides, Trails, and Trailheads – focus first on access points leading to areas of concern.	• Cultural /mechanical - isolated plants or small populations in spread zones. • Herbicide treatment for larger populations along perimeter.
Third Priority of Treatment	• Control[6] of existing large infestations (e.g. State-listed and Forest second priority species)	• Biocontrol on large infestations • Livestock grazing • Mechanical
Fourth Priority of Treatment	• Suppression[7] of existing large infestations when eradication/control or containment is not possible.	• Biocontrol on large infestations • Livestock grazing • Mechanical

---

[1] **Eradication:** Attempt to totally eliminate an invasive plant species from a Forest Service unit, recognizing that this may not actually be achieved in the short term since re-establishment/re-invasion may take place initially.
[2] **Category 3 Species** - These invaders are the highest priority for control. The discovery of any new populations would prompt immediate eradication action using the most efficient IPM approach. No populations of Category 3 invaders would be allowed to persist.
[3] **Category 2 Species** - Some infestations of Category 2 species are relatively large, yet they are still geographically limited to only a portion of the CNF. For this reason containment is the primary goal. If contained, many of these Category 2 species can be eradicated if acted upon immediately thus preventing these new invaders from affecting native plant communities. If eradication is not possible, then control and containment is the goal to at least limit the impacts these species would have on the native ecosystem. Category 2 invaders should therefore be prevented from infesting new areas, and should be eliminated in some existing populations, while the remainder would be contained.
[4] **Contain**: Prevent the spread of the weed beyond the perimeter of patches or infestation areas mapped from current inventories.
[5] **Category 1 Species** - Because most of these species exist in extensive, widespread infestations, a great deal of resources would be required to reduce or eradicate populations. For especially hardy species with extensive root systems, eradication of large infestations could prove to be impossible since we do not have the tools or technology to effectively kill all plant parts and prevent regrowth (Sheley and Petroff 1999). Therefore, the key management approach with these species is to control and contain existing populations (keep them from spreading into uninfested areas) and to eradicate new populations in uninfested areas. The IPM approach is to prevent Category 1 species from spreading beyond current infestations. Therefore, Category 1 invaders would not necessarily be eliminated, but infestation spread into uninfested native plant communities would be reduced.
[6] **Control**: Reduce the infestation over time; some level of infestation may be acceptable.

APPENDIX E
TREATMENT PRIORITIES, ADAPTIVE MANAGEMENT, AND MINIMUM TOOL GUIDELINES

ADAPTIVE MANAGEMENT APPROACH

The following adaptive management strategy applies to Alternative 1- Proposed Action and Alternative 2 – No Herbicide. However, herbicide aspects of the adaptive management strategy would not be available under Alternative 2. The adaptive management approach is made up of two principle components:

Principle 1: To quickly and effectively treat newly discovered weed infestations, a decision tree based on site characteristics, weed species, and location would be used to select treatment methods (see Appendix E, Table E-2). Using an adaptive management approach allows treatment of new sites or new species without a lengthy delay, while still addressing other resource concerns. Although treatments of weeds are expected to be effective in reducing existing weed infestations, all infestations cannot be treated immediately due to budgetary and logistical constraints. Existing infestations will expand before they can be treated, and new areas will be identified. Since every acre of the Custer National Forest has not been inventoried for weeds many existing sites have yet to be identified. Also, new invasive weed species may be added to the invasive weed list and they will be incorporated into this analysis. The strategy includes:

- The decision (if and how) to treat newly discovered infestations would be driven by the Decision Tree for New Weed Locations as shown in Appendix E, Table E - 2;
- New invaders, as identified by local and State agencies, should be given high priority for eradication, if feasible;
- New infestations may be treated with herbicide as long as the areas treated remain within the limits described in Appendix E, Table E – 1 and adhere to all protection measures listed in Appendix C; and
- Appropriate methods and environmental protection measures described in Appendices C and E would be used.

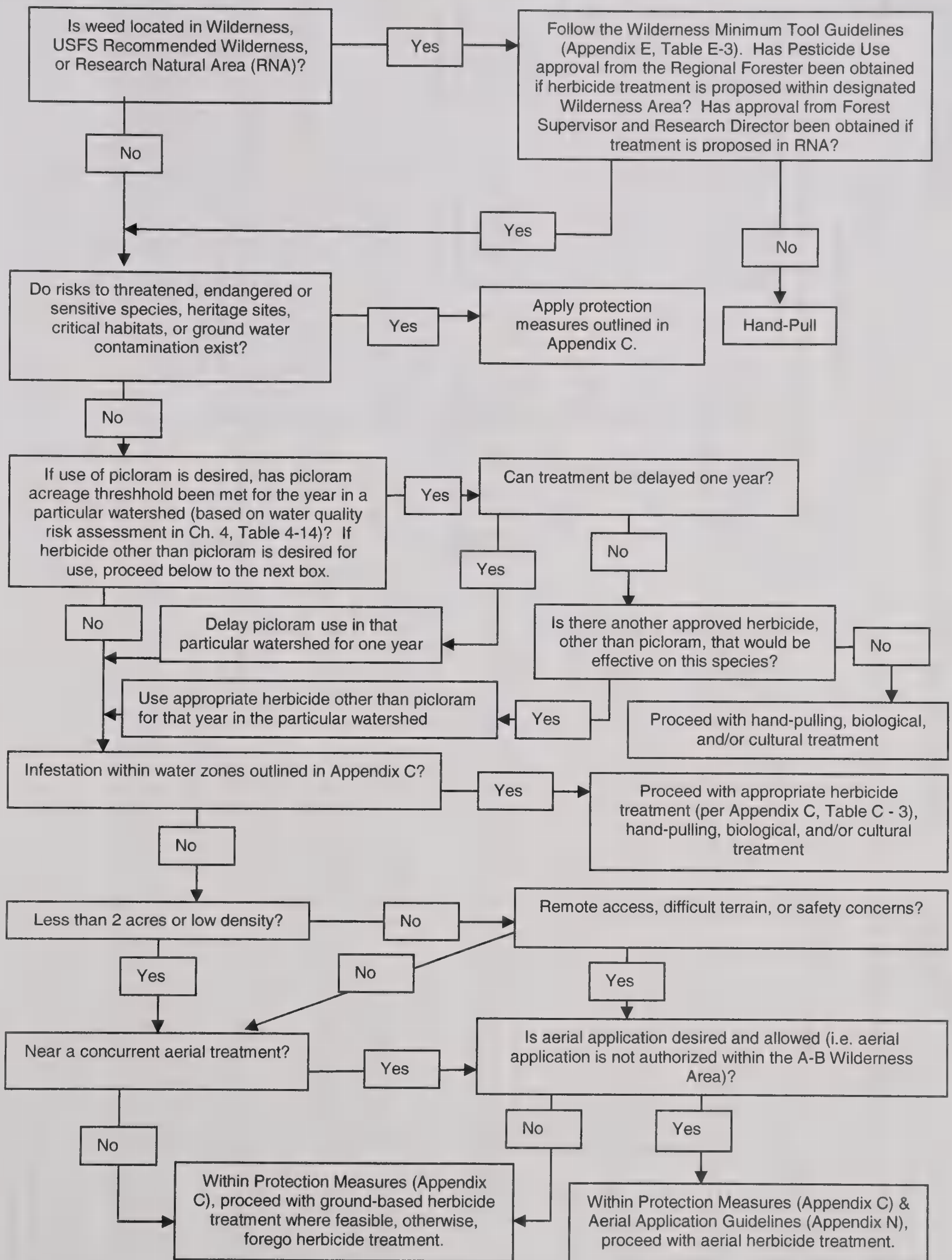
Principle 2: To improve effectiveness and reduce impacts, new technologies, biological controls, adjuvants, or herbicides would be evaluated for use. New technology, biological controls, herbicide formulations, and supplemental labels are likely to be developed within the next 15 years. These new treatments would be considered when there are indications that they would be more weed-specific than methods analyzed here, less toxic to non-target vegetation, or less persistent and less mobile in the soil. New herbicides may be used when they become available if they are permitted by the EPA, have a human health and environmental risk assessment completed per direction of Forest Service Handbook 2109.14, Chapter 10, and are registered for use by the states of Montana or South Dakota. The Adaptive Management Strategy would allow incorporation of these new products and treatment methods.

- New herbicides or formulations registered and approved by the US Environmental Protection Agency would be applied according to label specifications;
- Application methods and protection measures (environmental design criteria) described above would be used;
- The decision by the line officer to use a new treatment method would be driven by an interdisciplinary review (FSH 1909.15, 18.4) to confirm that the new treatment is within the scope of the analysis in this EIS, and a site characteristic evaluation (Appendix E, Table E - 2);
- A risk assessment must be completed per Forest Service Handbook 2109.14, Chapter 10 for the herbicide. These assessments could be completed by the Forest Service, the Natural Resources Conservation Service, USDA Agriculture Research Station, Environmental Protection Agency, or other authorized agency.
- New biological control agents that are approved and certified by the Animal Plant Health Inspection Service and the applicable State (Montana or South Dakota) prior to their introduction. Biological agents should be virtually harmless to native or desirable non-native plants, and;
- Cost effective mechanical methods of treatments are developed. These methods would be reviewed before use to determine if other resource quality standards can be maintained.

---

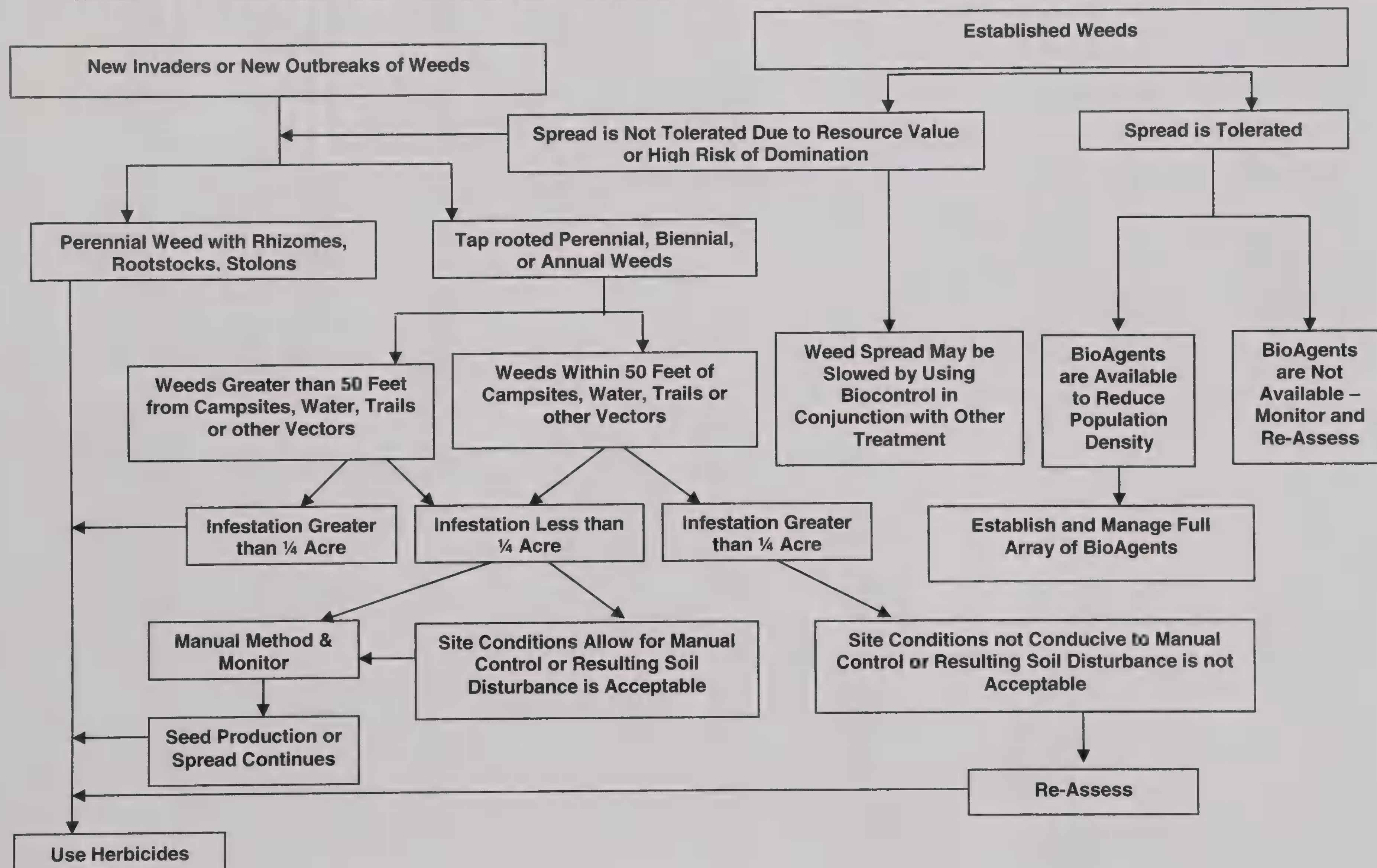
[7] **Suppress**: Prevent seed production throughout the target patch and reduce the area coverage. Prevent the invasive species from dominating the vegetation of the area; low levels may be acceptable.

APPENDIX E
TREATMENT PRIORITIES, ADAPTIVE MANAGEMENT, AND MINIMUM TOOL GUIDELINES
TABLE E - 2. DECISION TREE FOR NEW WEED LOCATIONS



APPENDIX E
TREATMENT PRIORITIES, ADAPTIVE MANAGEMENT, AND MINIMUM TOOL GUIDELINES

TABLE E – 3. MINIMUM TOOL GUIDELINES - FOR WILDERNESS AREAS, HIKING AREAS, OR OTHER REMOTE AREAS WITH DIFFICULT ACCESS



APPENDIX F
EFFECTIVENESS OF TREATMENTS BY SPECIES

TREATMENT EFFECTIVENESS GUIDE – INTEGRATED PEST MANAGEMENT[1]

MANAGEMENT METHODS: A person can use more than one method to manage noxious weeds. To control, reduce or eliminate noxious weeds use one or more of the following management practices. Only a few select weed species are represented in this guide. Table F – 1 outlines a quick guide to treatment effectiveness and Table F – 2 outlines species-specific response to various herbicides. More detailed effectiveness discussion is found in Appendix I. Tables F – 3 through F - 6 outlines shrub and tree treatment effectiveness/susceptibility by treatment type and herbicide.

Control Method	Leafy Spurge	Spotted Knapweed	Sulfur cinquefoil	Whitetop	Dalmatian Toadflax	Russian Knapweed	St. Johnswort	Canada Thistle	Hounds tongue	Salt Cedar
Cut/Mow	N; Ineffective, increases density	ME; Reduces seed; will not kill plant	N; Ineffective	N; Ineffective	N; ineffective	N; ineffective	N; ineffective	N; generally ineffective	ME; moderately effective	ME; Suckers From Stump E; Saplings only
Hand Pull	ME; only on small sites	E; only on small sites	ME; only on small young sites	ME; only on small young sites	ME; only on small young sites	ME; only on small young sites	E; only on small sites	N; Too spiny for hand pulling	N; ineffective	E; Saplings Only
Burn	N; ineffective, may increase density	N; ineffective, only use as spray pretreat	N; ineffective, may increase density	N; Ineffective, may increase density	N; ineffective, may increase density	N; Ineffective, may increase density	N; ineffective	N; ineffective	N; ineffective	N; ineffective
Herbicide[3]	E; can reduce and keep in check	E; very effective	E; very effective	E; very effective	E; can reduce weed and keep in check	E; very effective	ME; moderately effective; must be persistent	E; effective	E; effective on first year rosette; up to 6-10" tall regrowth	E; consistency important
Biological control	E; 5-10 years to establish; some effect on some sites	ME; Isolated effects; marginal long term	N; not available	N; not available	ME; effective on some sites	N; not available	ME; cyclical, effective on some sites	N; not effective	N; not available	ME; Available for some sites
Reseeding	E; effective as follow-up treatment	E; effective as follow-up treatment	E ;effective as follow-up treatment	N; Not Available	ME; limited effectiveness on marginal	N; Not Available	ME; limited effectiveness	ME; effective as follow-up treatment	E; effective as follow-up treatment	N; Not Available
Grazing	ME; suppressed by sheep and goats only	ME; sheep and goats keep weed in check	N; ineffective	ME; generally ineffective	N; ineffective	N; ineffective	N; poisonous plant	N; ineffective	N; poisonous plant	ME; goat grazing/girdling of bark
Cultivate, disc, till	ME; generally ineffective	E; effective	ME; generally ineffective	ME; Questionable over short term	ME; generally ineffective	ME; Generally ineffective	ME; generally ineffective	E; effective combined with herbicides; biennial	E; effective in some situations; not in crop ground	N; Not Available

[1] Montana Dept. of Ag, 2002
[2]
[3] See Appendix I for species and herbicide specific effectiveness information.

APPENDIX F
EFFECTIVENESS OF TREATMENTS BY SPECIES

TABLE F – 2. SPECIES RESPONSE TO RANGELAND HERBICIDES[4]

Species	2,4-D	Milestone (*Aminopyralid*)	Transline (*clopyralid*)	Curtail (*clopyralid + 2,4-D*)	Telar, Glean (*chlorsulfuron*)	Banvel, Clarity (*dicamba*)	Diuron 4L (diuron – at max. rate)	Roundup Ultra, Rodeo, Accord, Glyphomate (*glyphosate*)	Velpar L, Pronone 10G (*hexaxinone*)	Plateau (*imazapic*)	Arsenal, Chopper (*imazapyr*)	Escort (*metsulfuron*)	Tordon 22K (*picloram*)	Tordon 22K + *2,4-D* (*picloram + 2,4-D*)	Oust (sulfometuron)methyl)	Remedy, Redeem, Garlon (*triclopyr*)
Grasses																
downy brome					E		G	E	E					G	G	
quackgrass							G	G-E	G-E							
perennial grasses							G	G-E	G-E							
foxtail barley					G		G	G	E							
bulbous bluegrass					P		G	G	E							
Broadleaf Annuals																
bedstraw	P					G	G					G				
kochia	G			G	G	G	G	E					P			
russian thistle	G	G-E		G	G	G	G	E	G				F			
Biennials																
burdock	F			F			G					E				G
houndstongue	F			P		G	G					E	G			
mullein, common	F						G	G				E	F	G		
musk thistle	F	G-E	G-E	G-E		F	G					E	E	E		
plumeless thistle	G	G	E	E		E	G						E	E		
scotch thistle	F	G	E	G		F	G					E	E	E		
yellow starthistle	F	G	E	E		G-E	G					P	E	E		
Perennials																
field bindweed	F			P	P	F	P	F				F	G	G	G	
sulfur cinquefoil	G	G-E		P		P	G					E	E	E		G
common crupina	G			F		G	G	G				E	E	E		
dandelion	F		G	G	P	G	P	G	G			E	G	G		G
dyer's woad	G					F	G					E	P			
curlycup gumweed	G			E		G	G					G	E	E		
orange hawkweed		G-E	G	G		G	G					P	E	E		
yellow hawkweed	F	G-E	G	G		P	G					P	E	E		
horsetail							G		G			P				
diffuse knapweed	F	G-E	G-E	G-E		F-G	G	F				P	E	E		
Russian knapweed	P	G-E	G	G		F	G	P				F	E	E		
spotted knapweed	G	G-E	E	E		G	G	F	F			P	E	E		
larkspurs	F	G-E				P	G	G				E	E	E		

[4] Source: Bussan et al, 2001-2002.

Control Codes: **E = Excellent; G = Good, F = Fair; P = Poor or no control.**
Note: Absence of a weed from a label does not necessarily mean complete lack of control.

APPENDIX F
EFFECTIVENESS OF TREATMENTS BY SPECIES

Species	2,4-D	Milestone (*Aminopyralid*)	Transline (*clopyralid*)	Curtail (*clopyralid + 2,4-D*)	Telar, Glean (*chlorsulfuron*)	Banvel, Clarity (*dicamba*)	Diuron 4L (diuron – at max. rate)	Roundup Ultra, Rodeo, Accord, Glyphomate (*glyphosate*)	Velpar L, Pronone 10G (*hexaxinone*)	Plateau (*imazapic*)	Arsenal, Chopper (*imazapyr*)	Escort (*metsulfuron*)	Tordon 22K (*picloram*)	Tordon 22K + 2,4-D (*picloram + 2,4-D*)	Oust (sulfometuron)methyl)	Remedy, Redeem, Garlon (*triclopyr*)
locoweeds	G		G	E		E	G					E	E	E		
purple loosestrife	G						G	G				G				G
lupine	G			P		P	G					F-G	P	F		
plantain spp	G					F	G					G	G			
pricklypear cactus	P						G					P	E	E		
rush skeletonweed	F			G		F	G	P				P-F	E	E		
common tansy	P			F		F	G					E	G	G		
canada thistle		G-E	E	E		F	P	G				F	E	E		F
dalmatian toadflax						P	G			G		F-G	E-G	E-G		
yellow toadflax				P			G	G				F	G	G		
leafy spurge	F			P		F	G	G		G		P	G	G		
hoary cress (whitetop)	F						G	F				E	P			
Trees and Shrubs																
salt cedar[5]						P		F	F		G		P			
juniper*[2]									F-G				*			
poison ivy	E							E				F				G-E
grey rabbitbrush[3]	G					P			G					G		G
prickly rose								G	F			G				
big sagebrush	G-E		P			F		P	G				P			F-G
broom snakeweed	G		F			F			F			E	E	E		
pine spp					G				P			G		F		

Responses of weeds to any of the listed herbicides may be altered by growing conditions, weed populations, type of irrigation, genetic variations of weeds, soil type, pH, organic matter, time of application, and application rate. Ratings may vary from season-to-season and geographic areas within the area.

[5] *Individual plant treatments only
[2] Individual plant treatments only
[3] Need to be applied in early spring with reapplication one year later in early spring

APPENDIX F
EFFECTIVENESS OF TREATMENTS BY SPECIES

Shrubs and Trees

Herbicide drift onto adjacent desirable plants can be a problem when applying herbicides. Apply only when there is little or no hazard from spray drift. Do not spray when wind is blowing toward desirable plants that are near enough to be injured. When treating trees and brush use a low pressure coarse spray and treat all sides of the plant.

The following susceptibility charts[7] are to be used only as a guide when planning herbicide treatments. Consult research reports, product labels, and knowledgeable personnel for additional information.

TABLE F – 3. LABEL CLEARANCES FOR HERBICIDES

Herbicide	Type of Application					
	Foliar	Soil	Frill	Stump	Basal	Inject
2,4-D*[8]	x		x	x	x	x
Dicamba	x		x	x	x	
Glyphosate	x		x	x		x
Hexazinone	x	x				
Imazapyr	x		x	x	x	
Metsulfuron	x	x				
Picloram*	x		x	x		x
Triclopyr	x		x	x	x	x

TABLE F - 4. SUSCEPTIBILITY TO CUT SURFACE, INJECTION, AND STUMP TREATMENTS

Plant	Herbicide					
	2,4-D	Dicamba	Picloram plus 2,4-D	Triclopyr	Imazapyr	Glyphosate
Alder	G	G	G	G	G	G
Ash	P	F	F	G	G	G
Aspen	F	G	G	G	G	G
Cherry	G-F	G	G	G	G	G
Cottonwood	G	G	G	G	G	G
Douglas Fir	P		G	G		
Elm	F	G-F	G	G-F	G	G
Pines	F		G-F			
Russian-olive	F	F	F	F	G	G
Salt cedar[9]		G		G	G	G
Willow	F	G	G	G	G	F
G = Good control; F = Fair control, likely to need retreatment; P = Poor control						

[7] Washington State University Cooperative Extension. 1995. http://cru.cahe.wsu.edu/CEPublications/eb1551/eb1551.html
[8] All formulations of 2, 4-D* and picloram* are not suitable for all the uses indicated. Check manufacturer's label for uses and additional precautions. FOLLOW LABEL INSTRUCTIONS.
[9] Follow protection measures outlined in Appendix C for herbicide use near water.

APPENDIX F
EFFECTIVENESS OF TREATMENTS BY SPECIES

TABLE F - 5. SUSCEPTIBILITY TO FOLIAGE TREATMENTS

Plant	Herbicide						
	2,4-D	**Dicamba**	**Glyphosate**	**Picloram plus 2,4-D**	**Triclopyr**	**Imazapyr**	**Metsulfuron**
Alder	G	G	G	G	G	G	
Ash	P	G	G	P	F		G
Aspen	F-P	F	G	G-P	G	G	G
Chokecherry	G	F-P	G	G	G		
Cottonwood	F-P	G	G	F	G	G	G
Douglas Fir	F-P	G	G-P	G	G-P	G-F	
Elm	F-P	F-P	G	G	G-F	G	G
Pine	G	G	P	G	G	F	
Wild Rose		G	G	G	G		G
Russian-olive	F	G	G	G	F	G	
Sagebrush	G	G	F	G	G		
Snowberry	P	P	G	G-P	F	G	G
Sumac	G-F	G-F	G		G	G	
Willow	G-P	G-P	G-F	G-F	G-P	G	
G = Good control; F = Fair control, likely to need retreatment; P = Poor control							

TABLE F - 6. SUSCEPTIBILITY TO BASAL BARK TREATMENT

Plant	Herbicide			
	2,4-D	**Triclopyr**	**Hexazinone**	**Picloram**
Alder	G-F	G	G	G
Ash	P		G	
Aspen	G-F		G	G
Chokecherry	G-F	G		
Cottonwood	G	G		
Douglas Fir			P	G
Elderberry	G-F	G		
Elm	G-F	G-F	G	
Pine			P	G
Wild Rose			G	
Russian-olive			G	
Sagebrush	G			
Snowberry	F-P	F-P		
Sumac	P		G	G
Willow	G-F	G-F	G	
G = Good control; F = Fair control, likely to need retreatment; P = Poor control				

- End of Appendix F -

APPENDIX G
HERBICIDES, TRADE NAMES, AND TARGET SPECIES

HERBICIDES, TRADE NAMES, AND TARGET SPECIES

Table G – 1 contains a list of herbicides, a partial list of trade names, and associated targeted species addressed in this analysis. Table G – 2 outlines a Quick Guide for Treatment Methods by Species (a more detailed treatment by species can be found in Appendix I). Table G – 3 provides a quick guide to herbicide properties.

All herbicides will be applied according to label specification and protection measures required by Forest Service policy as described in this analysis (see Appendix C). Impacts on soil and water will be mitigated to meet public land water laws, state pesticide application requirements, Northern Region Soil and Water Standards, and Custer Forest Plan Standards.

One feature of the proposed action is the flexibility to use updated agents as they are registered and approved by the EPA. See Appendix E.

TABLE G – 1. EPA REGISTERED HERBICIDES AVAILABLE FOR CONTROL[1]

Common Name	Partial List of Trade Names	Target Weed Species (general)
2,4-D*	Hi-Dep®, Weedar 64®, Weed RHAP®, Amine 4®, Aqua-Kleen (Amines)	Foliage applied. Selective. Some broadleaf, woody and aquatic plants susceptible. Thistles, sulfur cinquefoil, dyers woad, knapweeds, purple loosestrife, tall buttercup, whitetop
Aminopyralid	Milestone	Foliage applied. Selective. Many broadleaf weeds. Tolerated by most grasses. Perennial and biennial thistles, knapweeds, sulfur cinquefoil
Chlorsulfuron	Telar®	Foliage applied. Selective. Some broadleaf plants and grasses susceptible. Dyer's woad, thistles, common tansy, houndstongue, whitetop, tall buttercup, toadflax
Clopyralid	Stringer®, Curtail®, Transline®, Redeem®	Foliage applied. Selective. Many broadleaf and woody species susceptible. Thistles, yellow starthistle, hawkweeds, knapweeds, rush skeletonweed, oxeye daisy
Dicamba	Banvel®, Clarity®, others	Foliage applied. Selective. Some broadleaf plants, brush and vines susceptible. Houndstongue, yellow starthistle, common crupina, hawkweed, oxeye daisy, tall buttercup, blueweed, leafy spurge, tansy ragwort, knapweeds
Diuron	Diuron 4L	Applied pre- or post-emergence. Broad spectrum. Most annual and perennial broadleaf plants, grasses and some woody vegetation. Annual weeds and broadleaves for infrastructure maintenance needs such as right-of-ways
Glyphosate	Roundup®, Rodeo®, Accord®, Glyphomate®	Foliage applied. Nonselective. Most plants are susceptible. Broad spectrum for broadleaf plants and grasses. Purple loosestrife, field bindweed, yellow starthistle, thistles, cheatgrass, common crupina, toadflax
Hexazinone	Velpar®, Pronone 10G®	Broad spectrum control with some selectivity for conifers. Cheatgrass, oxeye daisy, yellow starthistle, thistles
Imazapic	Plateau®	Foliage applied. Selective. Some broadleaf plants and grasses susceptible. Cheatgrass, leafy spurge, toadflax
Imazapyr	Arsenal®, Chopper®	Applied pre- or post-emergence. Broad spectrum. Most annual and perennial broadleaf plants, grasses and woody vegetation. Dyers woad, field bindweed
Methsulfuron methyl	Escort, Ally	Applied pre- or post-emergence. Selective. Some broadleaf weeds and annual grasses. Houndstongue, thistle, sulfur cinquefoil, common crupina, dyers woad, purple loosestrife, common tansy, whitetop, blueweed
Picloram*	Tordon®, Grazon®, Pathway®	Foliage applied. Selective. Most annual and perennial broadleaf and woody plants are susceptible. Grasses are tolerant. Thistles, yellow starthistle, common crupina, hawkweeds, knapweeds, rush skeleton weed, common tansy, toadflax, leafy spurge
Sulfometuron methyl	Oust®	Applied pre- or post-emergence. Broad spectrum. Many annual and perennial grasses and broadleaf plants. Woody vegetation tolerant. Cheatgrass, whitetop, oxeye daisy, tansy ragwort, musk thistle
Triclopyr	Garlon®, Redeem®, Remedy®	Foliage applied. Selective. Woody plants, some broadleaf plants, and root-sprouting species are susceptible. Grasses are tolerant. Hawkweed, sulfur cinquefoil, purple loosestrife, knapweed, oxeye daisy, thistle

[1] EPA Registered Herbicides Available for Control under Proposed Action - Alternative 1 (Alternative 3 Proposes Using Only 2, 4-D, Picloram, Dicamba, and Glyphosate). Ammonium sulfate, an adjuvant, can also be effective as an herbicide on tall larkspur.

APPENDIX G
HERBICIDES, TRADE NAMES, AND TARGET SPECIES

TABLE G – 2. QUICK GUIDE FOR TREATMENT METHODS BY SPECIES[2,3]

(See Appendix I for Detailed Information)

Noxious Weed (Known)	Treatment Method				
	Biological	**Herbicide[4]**	**Grazing**	**Mechanical[5]**	**Fire**
Leafy Spurge	Flea beetles (*Apthona nigriscutis, A. lacertosa, A. czwalinae, A. adominalis, A. cyparissiae, A. flava*) long-horned beetle (*Oberea erythrocephala*), gall midge (*Spurgia esulae*), Leafy spurge hawkmonth (*Hyles euphorbiae*)	picloram+ dichlorophenoxyacetic (2, 4-D), imazapic, dicamba, glyphosate, 2,4-D, sulfometuron methyl.	Sheep or goat grazing	Hand pulling	In combination with other treatments
Spotted knapweed	Root weevil (*Cyphocleonus achates*), knapweed root moth (*Agapeta zoegana*), knapweed flower weevils ***(Larinus minutus*** and *Larinus obtusus*), etc.	aminopyralid, triclopyr, clopyralid, picloram, clopyralid +2, 4-D		Hand Pulling	
Russian knapweed		aminopyralid, triclopyr, clopyralid, imazapic Metsulfuron methyl, clopyralid +2, 4-D		Hand Pulling	
Canada thistle	Thistle stem weevil (*Ceutorynchus litura*) thistle stem gall fly (*Urophora cardui*)	aminopyralid, clopyralid +2, 4-D, picloram, picloram+2, 4-D, triclopyr, 2,4-D clopyralid, imazapic		Mowing	In combination with other treatments
Saltcedar	*Diorhabda elongata* (leaf beetle)	imazapyr, imazapyr+ glyphosate, triclopyr		Cutting	In combination with other treatments
Absinth wormwood		picloram, clopyralid +2, 4-D, triclopyr, clopyralid, dicamba, 2,4-D, glyphosate		Mowing	
Musk thistle	Thistle crown weevil (*Trichosirocalus horridus*)	aminopyralid, picloram, clopyralid, triclopyr, metsulfuron methyl, dicamba+2,4-D			
Whitetop		imazapic, metsulfuron methyl, 2,4-D			
Houndstongue		picloram, 2, 4-D, imazapic, metsulfuron methyl		Hand Pulling	
Black henbane		picloram, glyphosate			
Plumeless thistle	Thistle crown weevil (*Trichosirocalus horridus*)	aminopyralid, picloram, clopyralid, metsulfuron methyl, triclopyr, dicamba+2,4-D		Mowing	
Bull thistle	Thistle crown weevil (*Trichosirocalus horridus*)	aminopyralid, picloram, clopyralid, metsulfuron methyl, triclopyr, dicamba+2,4-D		Mowing	
Perennial sow-thistle		2,4-D, dicamba, picloram		Mowing	
Field bindweed		2,4-D, dicamba, picloram, clopyralid, dicamba+2,4-D,		Hand Pulling	
Common Burdock		2,4-D, dicamba, imazapic, clopyralid, triclopyr, clopyralid +2, 4-D,		Hand Pulling	
Purple loosestrife	Leaf feeding beetle (*Galerucella pusilla, G. calmariensis*), Root mining weevil (*Hylobius transversovitatus*)	triclopyr, glyphosate, , imazapyr , 2, 4-D (water soluble), glyphosate, imazapyr		Hand Pulling	
E. watermilfoil		triclopyr, 2, 4-D (water soluble)			
Dalmatian toadflax	Biocontrol agents for this species can be effective in some locations	picloram+2, 4-D, imazapic, chlorsulfuron			
Yellow toadflax		picloram+2, 4-D,			
St. Johnswort		picloram, picloram +2, 4-D			
Yellow starthistle	Biocontrol agents for this species can be somewhat effective in some locations	picloram, triclopyr, clopyralid, imazapyr, clopyralid +2, 4-D		Hand Pulling	
Diffuse knapweed	Biocontrol agents for this species are effective	aminopyralid, clopyralid, triclopyr, picloram, imazapic, dicamba, clopyralid +2, 4-D		Hand Pulling	
Paved Road Maintenance		diuron, diuron + sulfometuron methyl			

[2] Prevention and Education are not identified in the table; however, they are an ongoing part of the control of all noxious weeds.

[3] Revegetation would likely be used in any situation where control of a noxious weed has resulted in the creation of bare ground patches greater then a quarter of an acre.

[4] Herbicide selection would be based on environmental conditions such as groundwater depth, soil type, non-target vegetation, and management objectives. Herbicide selection considers the following criteria: Herbicide label considerations; Herbicide effectiveness on target species; Proximity to water and other sensitive resources; Soil characteristics; Potential unintended impacts to non-target species such woody species or shrubs; Application method (aerial, ground, or wick applicator); Other weed species present at the site, and effectiveness of herbicides on those species (for example leafy spurge infestations with inclusions of Canada thistle); Timing of treatments (spring/fall); and Priority weed – new invaders vs. existing.

[5] Hand pulling is a treatment that would generally be applied for small numbers of plants.

APPENDIX G
HERBICIDES, TRADE NAMES, AND TARGET SPECIES

TABLE G – 3. QUICK GUIDE TO HERBICIDE PROPERTIES

Product Name	Active Ingredient(s)	Restricted[6]	Signal[7]	Human Health Findings				Persist - ence	Mobility	Bird	Fish	Bee	Wild - life
				Cancer[8]	Repro[9]	Neuro[10]	Endo[11]						
Arsenal	imazapyr		Caution	Evidence of non-carcinogenicity				Mod	High				
Banvel	dicamba		Warning	Not Classifiable as a Carcinogen				Low	V High				
Confront	clopyralid; triclopyr		Danger	Not Likely to be carcinogenic (clopyralid) Not classified as a carcinogen (triclopyr)				Mod	V High				
Crossbow	triclopyr; 2,4-D		Caution	Not Classifiable as a Carcinogen			Prob	Low,-Mod	Low-Mod		Toxic		
Direx 4L	diuron		Caution	Known/Likely				Mod	Mod				
Envy2,4-D	2,4-D		Danger	Not Classifiable as a Carcinogen			Prob	Low	Low-Mod				
Escort	Metsulfuron methyl		Caution	Not Likely to be carcinogenic				Low - Mod	High				
Garlon 3A	Triclopyr (amine)		Danger	Not classified as a carcinogen				Mod	V High				
Garlon4	Triclopyr (ester)		Caution	Not classified as a carcinogen				Mod	Low		Toxic		
Karmex	diuron		Caution	Known/Likely				Mod	Mod				
Lontrel	clopyralid		Caution	Not Likely to be carcinogenic				Med	V High				
Low Vol 4D	2,4-D		Caution	Not Classifiable as a Carcinogen			Prob	Low	Low-Mod				
Milestone	aminopyralid		None	Not Likely to be carcinogenic									
Oust	sulfometuron methyl		Caution	Evidence of non-carcinogenicity				Low	Mod				
Pathfinder II	triclopyr		Caution	Not classified as ■ carcinogen				Mod	Low		Toxic		
Plateau	imazapic		Caution	Evidence of non-carcinogenicity				High	High				
Rodeo	glyphosate		Caution	Evidence of non-carcinogenicity				Mod	E Low				
Roundup (18% conc)	glyphosate		Caution	Evidence of non-carcinogenicity				Mod	E Low				
Roundup Pro	glyphosate		Caution	Evidence of non-carcinogenicity				Mod	E Low				
Scotts 30-5-5 wConfront	triclopyr; clopyralid		Warning	Not Likely to be carcinogenic (clopyralid) Not classified as a carcinogen (triclopyr)				Mod	V High				
Telar	Chlorsulfuron 75%		Caution	Evidence of non-carcinogenicity				Mod	High				
Topsite	imazapyr; diuron		Caution	Known/Likely (diuron)				Mod	High				
Tordon 22K	picloram	Restricted	Caution	Evidence of non-carcinogenicity				Mod	V High				
Transline	clopyralid		Caution	Not Likely to be carcinogenic				Mod	V High				
Vanquish	dicamba		Caution	Not Classifiable as a Carcinogen				Low	V High				
Velpar	hexazinone		Danger	Not Classifiable as a Carcinogen				Mod	V High				
Weedar 64	2,4-D		Danger	Not Classifiable as a Carcinogen			Prob	Low	Mod				

[6] **Restricted.** A Restricted Use Pesticide is a pesticide that is available for purchase and use only by certified pesticide applicators or persons under their direct supervision. This designation is assigned to a pesticide product because of its relatively high degree of potential human and/or environmental hazard even when used according to label directions.

[7] **Signal Word.** The herbicide label indicates the extent of toxicity by the signal word(s) it carries. The signal word on the label applies to the most serious method or route of exposure. For example, if a herbicide has an acute oral LD50 of 368 (which triggers the signal word "Warning") and an acute dermal LD50 of >2,000 (which triggers "Caution") and is severely and irreversibly corrosive to the eyes (which warrants "Danger"), then the label signal word is "Danger."

[8] The EPA evaluates carcinogenicity (cancer), neurotoxicity, reproductive, teratology (birth defects), and mutagenicity (gene mutation) study results of herbicide effects to animals during the herbicide registration and re-registration processes. The study data is used to make inferences relative to human health.

Cancer column. When assessing possible cancer risk posed by a pesticide, EPA considers how strongly carcinogenic the chemical is (its potency) and the potential for human exposure. The pesticides are evaluated not only to determine if they cause cancer in laboratory animals, but also as to their potential to cause human cancer. For any pesticide classified as a potential carcinogen, the risk would depend on the extent to which a person might be exposed (how much time and to what quantity of the pesticide). The factors considered include short-term studies, long-term cancer studies, mutagenicity studies, and structure activity concerns. (The term "weight-of-the-evidence" is used in referring to such a review. This means that the recommendation is not based on the results of one study, but on the results of all studies that are available.). Diuron is a likely or known carcinogen. However, the EPA's 2002 re-registration assessment of the human and environmental scientific data reinforces a number of regulatory decisions and expert reviews that conclude the use of diuron according to product instructions does not present an unacceptable risk to human health or the environment.

[9] **Reproductive column.** EPA Registration / re-registration studies for the herbicides addressed in this analysis did not indicate any reproductive issues.

[10] **Neurotoxicity column.** EPA Registration / re-registration studies for the herbicides addressed in this analysis did not indicate any neurotoxicity issues.

[11] **Endocrine disruption column.** EPA Registration / re-registration studies for the herbicides addressed in this analysis did not indicate any reproductive issues except for probable issues for 2, 4-D. Based on currently available toxicity data, which demonstrate effects on the thyroid and gonads in test animals following exposure to 2, 4-D, there is concern regarding its endocrine disruption potential. There have been no studies on 2, 4-D that specifically assess its endocrine disruption potential. The EPA determined that a repeat 2-generation reproduction study is required to address these concerns. However, the EPA's 2005 re-registration assessment of the human and environmental scientific data reinforces a number of regulatory decisions and expert reviews that conclude the use of 2, 4-D according to product instructions does not present an unacceptable risk to human health or the environment.

- End of Appendix G -

APPENDIX H
GRAZING RESTRICTIONS BY HERBICIDE

GRAZING RESTRICTIONS BY HERBICIDE[1]

Herbicides sprayed on plants are not generally toxic to livestock. Certain unpalatable or poisonous plants treated with certain herbicides may become palatable to livestock. Be certain that livestock are kept out of areas where poisonous plants have been sprayed until the plants have dried up. Attention must be given to grazing restrictions outlined on the label. The restrictions will prevent residues that could stop the meat from being marketed.

Most herbicides have grazing and feeding restrictions stated on the label that limit the use of the area for livestock feed. Grazing and harvesting an area for feed following herbicide use often is prohibited because research on residue levels is inadequate. The effect of the chemical or its breakdown products on livestock or retention in the animal's body may not be known. Livestock which consume feed in areas treated with such herbicides probably would not become ill from the chemicals, but could retain the chemicals in their systems. The concern is that herbicides could be passed in the milk of lactating animals or cause abortion in pregnant animals. The chemical may also have potential to be retained by the animals and be present in the slaughtered carcass. Although these problems are not likely to occur, labeling restrictions are strict and should be adhered to. The presence of foreign chemicals in milk or meat of animals can result in confiscation and destruction of the products and loss of income from these animals.

The following table presents some of the grazing and feeding restrictions for herbicides commonly used. **The herbicide label is always the final authority on herbicide uses and precautions.**

Table I - 1. Grazing Restrictions for Rangeland Herbicides (always follow label as herbicide labels can change)

Herbicides	Rates		Lactating Dairy Animals		Beef and Non-Lactating Dairy Animals		Removal before Slaughter
	Product/A	Lb/A	Before Grazing	Before Hay Harvest	Before Grazing	Before Hay Harvest	
Aminopyralid (Milestone 2S)[2]	3 to 7 oz	0.047 to 0.109 ae	0	0	0	0	0
Clopyralid (Reclaim)			0	0	0	0	0
Clopyralid (Stinger 3E)a[2]	0.33 to 1.33 pt	0.12 to 0.5 ae	0	0	0	0	0
Clopyralid							
+ 2,4-D (Curtail 2.38S)	2 to 3 qts	1.19 to 1.78 ae	14 days	30 days	0	30 days	7 days[3]
+ MCPA (Curtail M 2.77S)	2 to 3 qts	1.38 to 2.0 ae	7 days	Not specified	0	Not specified	7 days[4]
Dicamba (Banvel 4S)	Up to 1 pt	0.5 ae	7 days	37 days	0	0	30 days
	Up to 2 pt	1.0 ae	21 days	51 days	0	0	30 days
	Up to 4 pt	2.0 ae	40 days	70 days	0	0	30 days
Banvel + 2,4-D/Weedmaster	0.5 to 4 pts	0.25 to 2.0 ae	7 days	37 days	0	0	30 days
Glyphosate (Roundup UltraMax 4S)							
Spot or Wiper[5]	labeled rate varies		14 days	14 days	14 days	14 days	0
Broadcast	labeled rate varies		8 weeks	8 weeks	8 weeks	8 weeks	0
Hexazinone (Velpar)							
Broadcast			8 weeks	8 weeks	8 weeks	8 weeks	0
Imazapic (Plateau 2L)	2 to 12 fl oz	0.032 to 0.189 ai	0	7 days	0	7 days	0
Metsulfuron methyl (Cimarron 60 DF)	0.1 to 0.4 oz	0.004 to 0.015 ai	0	0	0	0	0
metsulfuron-methyl + dicamba & 2,4-D (Cimarron Max)	0.25 to 1 oz + 1 to 4 pts	0.012 to 0.047 ai + 0.48 to 1.94 ae	7 days	37 days	0	0	30 days
Picloram[2] (Tordon 22K)	1 to 2 qts	0.5 to 1.0 ae	14 days	14 days	0/14 days[6]	0/14 days[6]	3 days[3]

[1] U of MN Extension Service, 2006.
[2] Move livestock to untreated grass pasture for 7 days before transferring livestock to broadleaf crop or pasture areas.
[3] Removal before slaughter is not needed if the restricted grazing interval has expired since application.
[4] Applies to grazing or hay harvested during the season of treatment.
[5] Do not treat more than one-tenth of any given acre at one time with spot or wiper applications. Remove livestock before application.

APPENDIX H
GRAZING RESTRICTIONS BY HERBICIDE

Herbicides	Rates		Lactating Dairy Animals		Beef and Non-Lactating Dairy Animals		Removal before Slaughter
	Product/A	Lb/A	Before Grazing	Before Hay Harvest	Before Grazing	Before Hay Harvest	
Picloram + 2,4-D (Grazon P+D)	1 to 4 pts	0.31 to 1.25 ae	7 days	30 days	0	30 days	3 days[3]
Triclopyr (Remedy 4 S)	≤2 qts	≤2.0 ae	14 days	Next season	0	7 days	3 days[4]
	> 2 to 4 qts >	2.0 to 4.0 ae	Next season	Next season	14 days[7]	14 days	3 days[4]
	> 4 qts	> 4.0 ae	Next season	Next season	14 days[7]	Next season	3 days[4]
Triclopyr + clopyralid[2] Redeem R & P 3 S)	1.5 to 4.0 pts	0.56 to 1.5 ae	14 days	Next season[8]	0	7 days[8]	3 days[4]
Triclopyr + 2, 4-D[2] (Crossbow 3S)	≤2 gal.	≤6.0	14 days	Next season[8]	0	7 days[8]	3 days[4]
	2 to 4 gal.	6.0 to 12.0	Next season	Next season	14 days[7]	14 days	3 days
2,4-D / MCPA[9]			7 days	30 days	3 days	30 days	0

[6] 14 days if >1 qt/A applied, 0 days if less than or equal to 1 qt/A.
[7] No grazing restriction if less than 25% of grazed area is treated.
[8] When harvesting green forage instead of dried hay, the less restrictive grazing restriction of 14 days applies for lactating dairy, or 0 days for beef and non-lactating dairy.
[9] Check individual product labels containing the same active ingredients for restrictions and use rates.

APPENDIX I
SPECIES SPECIFIC ECOLOGY AND IPM TREATMENTS – INCLUDING HERBICIDE RATES

SPECIES SPECIFIC ECOLOGY AND IPM TREATMENTS – INCLUDING HERBICIDE RATES

The following table displays species specific ecology and integrated pest management treatments for weeds on or adjacent to the Custer National Forest. The herbicides listed in the table are the most commonly used herbicides and rates are guidelines. In all cases, application rates would be those indicated on herbicide labels. On going testing may result in new instructions on rate and target species.

A surfactant is recommended with all herbicides except some formulations of glyphosate. A Methylated Seed Oil (MSO) is recommended with all Plateau applications for best results. See Appendix J for more information on surfactants.

Weed control from post-emergent herbicides is influenced by plant community tolerance, weed species, weed size, and climatic conditions. These factors should be considered in determining the herbicide selection and rate range. The lowest rate of post-emergent herbicides will be effective under favorable growing conditions and when weeds are small and actively growing. Use the highest labeled rate under adverse conditions and for well established weeds.

Efforts to utilize the most selective herbicide should be considered. A wide variety of herbicides have a wide range of plant selectivity.

- Glyphosate and Diuron are the least selective, affecting most plant species.
- Clopyralid (i.e., Stinger, Transline) is the most selective herbicide, affecting only plants in the sunflower (*Compositeae*), buckwheat (*Polygonaceae*), nightshade (*Solanaceae*), and pea (*Fabaceae*) families. About half of the existing Custer Forest weed species are in these families.
- Dicamba (i.e., Banvel), Picloram (i.e., Tordon), and 2, 4-D-amine are less specific. Monocots (grasses, grass-like plants, lilies, orchids and related families) are tolerant of Dicamba because of rapid metabolism (Sheley and Petrof, 1999); however, when mixed with other herbicides, it may be more lethal to some broad-leaved monocots.
- Picloram (i.e., Tordon), Overdrive, 2, 4-D, Clopyralid (i.e., Stinger, Transline) and Triclopyr (i.e., Remedy, Garlon 3A) can cause injury or death to forbs, trees & shrubs but are safe to most grasses.
- Supplemental labeling for Tordon 22K for areas west of the Mississippi River allows for wick or carpet roller applications where drift presents a hazard to susceptible crops, surface waters, and other sensitive areas. One part Tordon 22K is mixed with 2 parts water to prepare a 33% solution.
- Aminopyralid very effective and more environmentally friendly than picloram for control of perennial and biennial thistles, and knapweeds. Can be used in riparian areas up to water's edge. Not to be used in areas of standing water. Picloram, rather than aminopyralid, might be considered for drier upland treatments due to its more residual nature.
- Imazapic (i.e. Plateau) may be used safely around trees and over-the-top of many legumes and wildflowers. Some cool-season grasses may be injured or seedhead production may be inhibited. When permitted by the label, the use of a methylated seed oil (MSO) surfactant will provide the best results for control, but avoid MSO's when applying to emerged seedling grasses and forbs.
- Imazapyr (i.e. Arsenal), Sulfometuron (i.e., Oust) and Glyphosate (i.e., Roundup) herbicides will control almost all vegetation sprayed. Glyphosate does not have soil residual.
- Metsulfuron (i.e., Ally, Escort) can cause injury or death to certain trees, shrubs, forbs and grasses.

Conversion Factors (see Appendix L for more conversions)

- 43,560 sq. ft. = 1 acre
- 1 ounce = 28.35 grams
- 16 ounces = 1 pint
- 2 cups = 1 pint
- 30 cc's = 1 fluid ounce
- 1 cup = 8 ounces
- 2 teaspoons = 1 tablespoon
- 2 tablespoons = 1 fluid ounce

SPECIES SPECIFIC ECOLOGY AND IPM TREATMENTS – INCLUDING SUGGESTED HERBICIDE RATES [1]

Common & Scientific Name	Habitats; Life Cycle; & Modes of Reproduction	Biocontrol Agents	Mechanical & Cultural Methods	Herbicide Use: Herbicide & Method	Herbicide Use: Rate[2]	Herbicide Use: Timing
ESTABLISHED INVADERS – CATEGORY 1 SPECIES						
Russian knapweed *Acroptilon repens*	Prefers heavy, often saline soils of bottomlands and sub-irrigated slopes and plains. Commonly found along roadsides, riverbanks, irrigation ditches, pastures, waste places, clearcuts, croplands, and hayfields. Prefers similar sites to those occupied by basin wildrye (*Elymus cinereus*). Does not readily establish in healthy native vegetation, requires disturbance. The healthier the native vegetation, the less susceptible it will be to Russian knapweed invasion. (Once established, it emits allelopathic compounds to inhibit other plants). Long-lived perennial (75 years) A single plant may produce 1,200 seeds, which remain viable two to three years. Although Russian knapweed produces seeds, it does not reproduce extensively from seed. Infestations increase primarily vegetatively through adventitious buds on a creeping root system. Roots, which are both vertical and horizontal in the soil, may or may not be black with a scaley appearance. Roots grow 6 to 8 feet deep the first season and 16 to 23 feet deep in the second season.	Gall-forming nematode (*Subanguina picridis*) Seed head gall fly (*Urophora quadrifasciata*) Seed head gall fly (*U. affinis*)	Cultivation, cutting/mowing, and/or hand-pulling not recommended unless done three times per year (spring, summer, fall) to force the plants to use nutrient reserve stored in roots, followed by herbicide treatment. This protocol must be followed for at least 3 years otherwise it will stimulate sprouting from rhizomes. It is difficult to remove all roots with a one-time effort. Severed root pieces as small as 2.5 cm can generate new shoots from depths to 15 cm. Whichever control combination is chosen, it is imperative to continually stress the plant because it does not do well under stressful conditions. The most preferred method of control is to mow the area of Russian knapweed once a month during the spring and summer months, then follow up with an application of Tordon or 2, 4-D in the fall. Chemicals are not always necessary if the plant is stressed by mechanical methods and proper cultural techniques are applied. Long-term reductions must include planting competitive plant species to occupy bare ground once infested by the weed, due to Russian knapweed's allelopathic qualities.	 Tordon Curtail Redeem Transline Telar Milestone Tordon Curtail Redeem Telar Russian Knapweed (as well as Kochia and Russian Thistle) can sometimes develop resistance to many chemical formulations. It is recommended to use the sulfonylureas inhibitors such as: Escort, Telar, Ally, Oust, Glean, Plateau, Curtail, or Tordon.	***Per Acre Rate*** 2 quarts per acre 2 to 3 quarts per acre 3 to 4 pints per acre 1 1/3 pints per acre 2 oz. per acre 4-6 oz. per acre ***3 Gallon Backpack*** 4.5 oz per 3 gallons water 4.5 to 6.5 oz per 3 gallons water 4 oz per 3 gallons water 0.5 oz. per 3 gallons water	Before full flower or during fall re-growth
Whitetop (Hoary cress) *Lepidium draba*	Non-shaded, disturbed conditions, including roadsides, waste places, fields, gardens, feed lots, watercourses, open grasslands, and along irrigation ditches. Not particular about soil type, even saline soils, except for highly acidic soils. Most aggressive, rapid expansion occurs in irrigated conditions or during moist years. Whitetop is one of the earliest perennial	None currently available	Manual, mechanical, and cultural control practices have provided little success. Mowing or grazing with sheep or goats during bud stage and again during rebud (follow by herbicide). Hand pulling or digging must remove all roots and continue for 2 to 5 years to eradicate.	 Escort Telar Plateau	***Per Acre Rate*** 0.5 to 1 oz per acre + surfactant ¾ to 1 oz per acre + silicone surfactant 8 to 12 oz per acre + MSO	Treat prior to or at early flowering and fall regrowth Pre-bloom

[1] Carbon and Madison Counties, Montana 2002. Most rate guidelines are suggested by local county weed specialists (Carbon and Madison Counties, Montana); http://mtwow.org/Chemical-control.htm . Other rate guidelines come from:

- USFS, 2005. USDA Forest Service, Pacific Northwest Region. Preventing and Managing Invasive Plants Final EIS Appendix. Common Control Measures. Prepared by Linda Mazzu.
- USFS 2006. USDA Forest Service. Pesticide Management and Coordination web site: http://www.fs.fed.us/foresthealth/pesticide/index.shtml
- North Dakota State University, 2005. North Dakota Weed Control Guide by R. K. Zollinger, NDSU Extension Weed Specialist: http://www.ag.ndsu.nodak.edu/weeds/w253/w253-2a.htm#Troublesome
- University of Idaho Extension, 2005. Idaho's Noxious Weed Control Guide, 2005. http://info.ag.uidaho.edu/pdf/BUL/BUL0816-05.pdf

APPENDIX I
SPECIES SPECIFIC ECOLOGY AND IPM TREATMENTS – INCLUDING HERBICIDE RATES

Common & Scientific Name	Habitats; Life Cycle; & Modes of Reproduction	Biocontrol Agents	Mechanical & Cultural Methods	Herbicide Use		
				Herbicide & Method	Rate[2]	Timing
	weeds to emerge in the spring. Flowers are produced in late April and May and begin producing seeds about a month later. After blooming, the plants continue to grow until frost. If conditions remain suitable, they will flower and produce a second crop of seeds late in the summer. A single plant can produce from 1,200 to 4,800 seeds each year. Buried seeds remain viable for about three years. Whitetop has deep creeping roots.		Presence of competing vegetation, particularly shrubs, vetch, lupine, and other nitrogen-fixing legumes	Banvel +2-4D Banvel +2-4D	1 quart Banvel + 1 quart 2,4-D per acre + surfactant ***3 Gallon Backpack*** 2.25 oz Banvel + 2.25 oz 2,4-D + surfactant	
Spotted knapweed *Centaura maculosa*	Best adapted to well-drained, light-textured soils in areas that receive some summer rainfall. This includes ponderosa pine and Douglas-fir forests and shrub-steppe habitats with bluebunch wheatgrass, needle-and thread and Idaho fescue. The biggest enemy of spotted knapweed is irrigation or wetter than normal areas. Once established, it emits allelopathic compounds to inhibit other plants. The roots give off a chemical reaction that kills other plants surrounding it. This then leaves bare ground for new knapweed plants to sprout and grow thus increasing size and density of an infestation. This eventually results in a monoculture of knapweeds. Biennial or short-lived perennial Each plant can produce 400 or more seeds per flower stalk and up to 40,000 seeds per plant. Most seeds fall within a 3-4 foot radius of the parent plant. Seeds are viable for 7 to 20 years and germinate throughout the growing season. Spotted knapweed seeds germinate in either spring or fall. Plants may stay in the rosette stage for multiple years before bolting. Typically, the species bolts for the first time in May during its second growing season and flowers in July/August and sometimes continues growth into September.	Seed head gall fly (*Urophora affinis*) Seed head gall fly (*U. quadrifasciata*) Seed head fly (*Chaetorellia acrolophi*) Seed head moth (*Metzneria paucipunctella*) Seed head weevil (*Bangasternus fausti*) Seed head weevil (*Larinus minutus*) *Larinus obtusus* Black leaf blight fungus (*Alternaria alternata*) Root moth (*Agapeta zoegana*) Verdant seed fly (*Terellia virens*) Root weevil (*Cyphocleonus achates*) Fungus (*Sclerotinia*) Most promising bioagents are the two seed-head attacking flies *Urophora affinis* and *U. quadrifasciata*.	Hand-pulling of small infestations (usually takes 7 to 10 years). The entire root crown must be completely removed. In stands with little other vegetation, it may be possible if mowing occurs just after most flowering has ended, but before sees have matured. Mowing combined with mulching may increase effectiveness. Mowing may cause low growing forms. It is considered moderately effective. Long term grazing by sheep and goats has been found to control spotted knapweed. Prescribed burning alone is probably not effective for controlling spotted knapweed and may cause increases. Studies have shown that moderate increases occur after fire. Established stands may be reduced by hot, prescribed burns. Fire may be useful in conjunction with herbicides under the right conditions by reducing old stem densities. A fuel model has been developed for this species. The fire severity depends on the amount of dry knapweed stems and the amount of fine grass fuels. Regular cultivation/seeding. Plowing soils under to 7 inches, allowing 4-6 weeks for re-germination and then repeating for one growing season has been successful. Herbicide application may make cultivation more effective for large infestations For cultural controls, desired grasses should be planted during the fall to maximize establishment success. Sheep, goats and cattle will consume spotted knapweed without any adverse effects. Generally this can be an effective method if it coincides with cultural practices and proper grazing management practices are used.	 2-4D Tordon Tordon + 2-4D Curtail Milestone 2-4D Tordon Tordon + 2-4D Curtail Transline Redeem Transline Redeem An application of Banvel plus 2, 4-D, Tordon plus 2, 4-D, clopyralid plus 2, 4-D or Banvel plus Tordon will control spotted knapweed. Tordon is often chosen because the residual activity of this herbicide provides long-term suppression. Aminopyralid, however, can be used in riparian	***Per Acre Rate*** 2 quarts per acre 1 pint per acre 1 pint Tordon + 1 quart 2-4D per acre 2 to 3 quarts per acre 5-7 oz. per acre ***3 Gallon Backpack*** 4.5 oz per 3 gallons water 1.5 to 2 oz per 3 gallons water 1.5 oz Tordon + 2.25 oz 2-4D per 3 gallons water 4 to 4.5 oz per 3 gallons water ***Per Acre Rate*** 1 1/3 pints per acre 1.5 to 2 pints per acre ***3 Gallon Backpack*** 1.5 oz per 3 gallons water 1.5 to 2 oz per 3 gallons water	Actively growing (early rosette stage) in the spring, bolt to early bud, or during fall growth Rosette to bloom

Common & Scientific Name	Habitats; Life Cycle; & Modes of Reproduction	Biocontrol Agents	Mechanical & Cultural Methods	Herbicide Use		
				Herbicide & Method	Rate[2]	Timing
				areas where picloram (Tordon) cannot be used. *Transline: Offsite drift may cause damage to sensitive plants up to 300 feet. Little effect on grasses. Use backpack or wick to minimize drift. Transline is less persistent than picloram. More selective than picloram.		
Diffuse knapweed *Centaurea diffusa*	Biennial or short-lived perennial Abundant seed production. A single plant can produce up to 18,000 seeds. Seeds germinate in both early spring (primarily) and fall. In the fall, diffuse knapweed breaks off at ground level and disperses widely as a tumbleweed. The allelopathic chemical may reduce recovery potential as its presence in the soil may hinder the resurgence of natives. Also dormant seeds may germinate and re-infest an area.	Knapweed flower weevil (*Larinus minutus*) and bronze knapweed root borer (*Sphenoptera jugoslavica*) are more effective biocontrol agents than the following agents: seed head gall fly (*Urophora affinis*); seed head gall fly (*U. quadrifasciata*); peacock fly (*Chaetorellia acrolophi*); seed head weevil (*Bangasternus fausti*); root weevil (*Cyphocleonus achates*) None of these, alone or in combination effectively control populations. They may prove useful as part of an integrated program to weaken plants therefore making them more susceptible to other treatments.	Hand-pulling of small infestations (usually takes 7 to 10 years). Dig rosettes in the spring. Pull mature and immature plants in early summer before seeds form. Pull and bag (to remove seed from area) remaining plants in mid to late summer. All of the infestation must be pulled. All of the taproot must be removed. Mowing could increase populations of this species. Grazing is not an effective control method. It is generally unpalatable and the spines can injure livestock. Fire may be effective in controlling this species. Low-severity fire may only top-kill diffuse knapweed. Dry soil conditions associated with burns may discourage reinfestation as moisture is the limiting factor for seed germination. Re-seeding of desirable species may be necessary. A fuel model developed for spotted knapweed may be useful to managers planning to burn fields infested with diffuse knapweed. Using prescribed fire to reduce big sagebrush in semiarid grasslands may expose sites to invasion by diffuse knapweed. Replanting is preferred over allowing natural recovery. A native or less persistent species is preferred.	 2-4D Tordon Tordon + 2-4D Curtail Banvel + 2,4-D Milestone 2-4D Tordon Tordon + 2-4D Curtail Transline Redeem Transline Redeem	***Per Acre Rate*** 2 quarts per acre + surfactant 1 pint per acre + surfactant 1 pint Tordon + 1 quart 2,4-D per ac + surfactant 2 to 3 quarts per acre + surfactant 1 pint Banvel + 2 pints 2,4-D per acre + surfactant 5-7 oz. per acre ***3 Gallon Backpack*** 4.5 oz per 3 gallons water 1.5 to 2 oz per 3 gallons water 1.5 oz Tordon + 2.25 oz 2-4D per 3 gallons water 4 to 4.5 oz per 3 gallons water ***Per Acre Rate*** 1 to 1 1/3 pints per acre + surfactant 1.5 to 2 pints per acre + surfactant ***3 Gallon Backpack*** 1.5 oz per 3 gallons water 1.5 to 2 oz per 3 gallons water	 Actively growing (early rosette stage) in the spring, bolt to early bud, or during fall growth
Canada thistle *Cirsium*	Several ecological types. Prefers and is invasive in prairies and other grasslands and riparian areas with deep, well aerated, mesic soils, but also occurs in almost	Stem-boring beetle (*Centorhyncus litura*) Gall fly (*Urophora*	Removing flowers to prevent seed production. Mowing may only be effective in rare		***Per Acre Rate***	 Before seed set or during fall re-

SPECIES SPECIFIC ECOLOGY AND IPM TREATMENTS – INCLUDING HERBICIDE RATES

Common & Scientific Name	Habitats; Life Cycle; & Modes of Reproduction	Biocontrol Agents	Mechanical & Cultural Methods	Herbicide Use		
				Herbicide & Method	Rate[2]	Timing
arvense	every upland herbaceous community, especially roadsides, abandoned fields, and pastures. Perennial and rhizomotous. Reproduction by seeds, and shoots from lateral roots. Dormant, buried seeds can remain viable for up to 26 years. It readily roots from fragments less than an inch in length. Flowering occurs during July and August. Canada thistle differs from other species of the true thistle in that there are male and female flower heads, and these are on separate plants. By asexual reproduction, it is possible that a colony of male plants would produce no fruits, but still maintain itself. A Canada thistle shoot can produce as many as 100 heads in a season, with each head containing as many as 100 seeds. Horizontal root growth can extend more than 19 feet in one season and may eventually penetrate into the soil as deep as 22 feet. Left undisturbed, a Canada thistle plant can produce 26 adventitious shoots, 154 adventitious root buds, and 364 feet of roots after 18 weeks of growth. A one year growth study showed a root segment had grown 1,700 feet of roots and turned into a 142-plant colony. At that density, 4.5 acres of thistle roots would stretch from Chicago to Denver – 1,020 miles. The thistle root averaged 2.5 feet of root growth per day. Management should be designed to kill established clones since the species spreads primarily by vegetative expansion of the root system. It takes at least two growing seasons to determine whether a particular control method is effective.	*cardui*) Shoot fungus (*Sclerotinia sclerotiorum*) Seed head weevil (*Larinus planus*) Defoliating beetle (*Cassida rubiginosa*) Overall, this method provides little or no control, although some agents weaken and kill individuals. Most biocontrols are not adequately synchronized with its life cycle in North America. Management that delays flowering, such as mowing or burning, may help to synchronize a more susceptible stage with biocontrol agent's life cycle. At least three agents may be needed for effective control.	cases where it can be repeated at monthly intervals. This intensity is not recommended in natural areas, where it would likely damage native vegetation, but may be practical along roadsides. Mowing just twice a year, in mid June and September may reduce or contain Canada thistle. When mowing, cut high enough to leave >9 leaves per stem, or > 20 centimeters of bare stem tissue, as mature Canada thistle leaves and stems independently inhibit development of shoots from rootbuds. Smothering Canada thistle with boards, sheet metal or tar paper can kill plants. Above ground parts will be killed by fire, but below ground parts will survive even severe fires. There is abundant evidence that post-fire establishment of Canada thistle is common where seed source is available. Results are mixed on the use of prescribed fire as a management tool. Prescribed burns may be effective at stimulating growth of native species and thereby discouraging the growth of this invasive. It may be best if timed to emulate the natural fire regime of a site. Late spring burns may discourage the species, yet early spring burns may encourage it. Dormant season burning may be preferred because it stimulates growth of native vegetation, but may not be as effective as late spring burning. Annual burns for several years may be required. Revegetation for shade. Cultivation not recommended. Hand pulling or grubbing is not considered to be an economically effective means of controlling an established stand of Canada thistle.	Tordon + 2-4D Curtail Escort Banvel + 2,4-D Rodeo (in wetlands) Telar Transline Redeem Milestone Tordon + 2-4D Curtail Redeem Escort Single herbicide applications generally do not provide long-term control due to the difficulty in killing the root system, which can survive even though the shoots have been killed. It is more effective to combine control methods. In most instances, the most effective method for control is to combine two or three mowing operations with a fall application of 2,4-D, dicamba, clopyralid, metsulfuron, picloram, glyphosate, or chlorsulfuron. Mowing operations stimulate vegetative growth, which weakens the plants food supplies, and the fall herbicide application continues to weaken the plant. Due to the aggressive biology of Canada thistle, re-treatments are necessary.	1 quart Tordon + 1 quart 2-4D per acre 2 to 3 quarts per ac + surfactant 0.75 to 1.0 oz per acre 1.5 pints Banvel + 2 pints 2,4-D per acres + surfactant 1 quart per ac + LI700 surfactant 1.5 oz/A 2/3 pint per acre 3 to 4 pints per acre 5-7 oz. per acre ***3 Gallon Backpack*** 1 oz Tordon + 2.25 oz 2-4D per 3 gallons water 4.5 to 6.5 oz per 3 gallons water 4 oz per 3 gallons water 3/10 oz per 3 gallons water	growth Transline: Up to bud stage Redeem: Rosette to bud
Field bindweed *Convolvulus*	Perennial Seeds (viable up to 50 years) and creeping deep roots.	Leaf-galling mites (*Aceria malherbae / A. convolvuli*)	Hand-pulling (and cultivating) must be done for 3 to 5 years every 2 weeks to be effective.		***Per Acre Rate***	Before seed set or during fall regrowth

Common & Scientific Name	Habitats; Life Cycle; & Modes of Reproduction	Biocontrol Agents	Mechanical & Cultural Methods	Herbicide Use		
				Herbicide & Method	Rate[2]	Timing
arvensis	Field bindweed is one of the most persistent and difficult-to-control weeds. It has a vigorous root and rhizome system that makes it almost impossible to control with cultivation. Its seed has a long dormancy and may last in soil for up to 60 years. It has a climbing habit that allows the plant to grow through mulches. Field bindweed is also very drought tolerant and once established is almost impossible to control with herbicides.		Grazing or mowing are not effective controls. Cultivation and herbicide treatment can be used. If herbicides are to be used, treat the bindweed plants before they are drought stressed. Re-treatments will be necessary to control both established plants and seedlings. If possible, grow a competitive planting of other plants to reduce field bindweed growth. Establish and maintain healthy native vegetation, especially perennial grasses.	Tordon + 2-4D Banvel + 2,4-D Clarity Tordon + 2-4D Banvel + 2,4-D Clarity	1 to 2 pints Tordon + 1 quart 2,4-D per acre 1 quart Banvel + 1 quart 2,4-D per acre 1 to 2 pints per acre ***3 Gallon Backpack*** 1 oz Tordon + 2.25 oz 2-4D per 3 gallons water 2.25 oz Banvel + 2.5 oz 2,4-D per 3 gallons water 1.1 to 2.25 oz per 3 gallons water	
Hounds – tongue *Cynoglossum officinale*	Houndstongue is a biennial or short-lived perennial species, which forms rosettes in the first year and flowers in the second. It flowers between May and July. It has a thick branching taproot, extending to depths >40 inches. It often occurs in dense stands. Seedlings are usually clustered around parent plants in densities of up to 405 seedlings per square foot. Estimates of total seed number per plant range from 50 to more than 2,000. Its spiny husk and protruding barbs enable long distance dispersal to occur. Seeds attach to fur and clothing. Seed viability in the soil is relatively short compared to other invasive plants. Seed can remain viable above ground on plants for up to two years. Houndstongue is most abundant in areas with more than 10 percent bare ground. Germination starts in late winter and early spring. Houndstongue is toxic, containing pyrrolizidine alkaloids, causing liver cells to stop reproducing. Animals may survive for six months or longer after they have consumed a lethal amount. Sheep are more resistant to Houndstongue poisoning than are cattle or horses. Horses may be especially affected when confined in a small area infested with Houndstongue and lacking desirable forage.	Biological controls are being screened for possible use. One is approved in Canada. A native bacterium is being tested at Montana State University as an effective biological control as well. Spraying the plant with these bacteria interferes with its production of chlorophyll, weakening it so it will not re-sprout the following year.	Surface cultivation, digging and hand pulling are considered ineffective means of control because plants are capable of regenerating from the root crown. Hand pulling can reduce the size of populations up to 85%, though, if roots are completely removed. Hand-pull before flowering. Severing the root crown 1 to 2 inches below the soil surface with a spade and removing top growth can be effective in controlling small infestations when done before flowering. Mowing at ground level can reduce re-growth by 60% as well as seed production in some cases. Plowing is said to control houndstongue, but may not be appropriate in most areas. Keep and maintain vigorous vegetative cover. Houndstongue seedlings have a comparatively low growth rate and are not strongly competitive. Interspecific competition can severely reduce the dry weight of first and second year plants. Therefore, revegetation can effectively control houndstonge re-introduction, although more research is needed.	 2-4D Amine Tordon + 2-4D Escort Telar Plateau Banvel + 2,4-D Curtail 2-4D Amine Tordon + 2-4D Escort	***Per Acre Rate*** 2 quarts per acre 1 pint Tordon + 1 to 2 pints 2-4D per acre+ MSO + surfactant 0.5 to 1 oz per acre + MSO + surfactant 1 oz per acre 8 oz per acre + MSO Banvel 2 pints / ac + 2,4-D 2 pints+ MSO Per acre + surfactant 2 quarts per acre + surfactant ***3 Gallon Backpack*** 1 oz per 3 gallons water 1 oz Tordon + 1.12 oz 2-4D per 3 gallons water 3/10 oz per 3 gallons water	Before seed set or during fall regrowth Escort rosette to bolt. Telar in the Fall. Before seed set or during fall regrowth
Leafy spurge	Occurs on untilled, non-cropland habitats, including both disturbed and undisturbed sites, especially abandoned cropland,	flea beetle (*Aphthona abdominalis*)	No mechanical methods have been found to work effectively alone. Hand-pulling, digging, and tilling are only successful if		***Per Acre Rate***	Before seed set or

SPECIES SPECIFIC ECOLOGY AND IPM TREATMENTS – INCLUDING HERBICIDE RATES

Common & Scientific Name	Habitats; Life Cycle; & Modes of Reproduction	Biocontrol Agents	Mechanical & Cultural Methods	Herbicide Use		
				Herbicide & Method	Rate[2]	Timing
Euphorbia esula	pastures, rangelands, woodlands, roadsides, and waste places. Tolerant of a wide range of soils from rich, moist soils of riparian zones to nutrient-poor, dry soils of western rangelands. It is most aggressive in semi-arid situations where competition from associated species is less intense, so invades most rapidly on dry hillsides, dry prairies, or rangelands. Perennial and rhizomotous. Seeds (viable up to 8 years, usually germinate within 2 years), and spreading roots. Each flowering stem produces an average of 140 seeds. When the plant matures, the seed capsule explodes and launches the seeds up to 15 feet. Seed production, which ranges from 25 to 4,000 pounds per acre depending on plant density and site productivity, is usually completed by mid-August. Seedlings have capacity for vegetative reproduction and can develop root buds with 7 to 10 days of emergence. Roots have been excavated to a depth of over 4 meters and found at 30-35 feet in length. Root systems of well-established older plants can regenerate from fragments even if roots are removed to a depth of three feet. The latex can cause blistering and skin irritation to cattle and can have ill effects when it comes into contact with humans.	flea beetle (*A. nigriscutis)* flea beetle (*A. lacertosa)* flea beetle (*A. czwalinae)* flea beetle (*A. cyparissiae)* flea beetle *(A. flava)* hawk moth (*Hyles euphorbiae*) Long horned beetle (*Oberea erythrocephala*) Gall midge (*Spurgia esulae*) Some success has been found with the flea beetle combined with fall herbicide treatments.	the entire root system can be excavated, and may increase the number of plants if any remnants remain in the soil. Repeated mowing/cutting before flowering in conjunction with use of herbicides for adequate control of stand expansion. Mowing is ineffective when used alone. However, it does reduce seed production and dispersal and disrupts root vigor, making the plants more susceptible to pathogens. Mowing increases the effectiveness of herbicides by making the stand of leafy spurge more uniform, improving the coverage of the chemical treatment. Grazing by sheep or goats can be a very effective tool for controlling leafy spurge populations. Leafy spurge is not toxic, and in fact, is very nutritious, providing good forage. Light, periodic cultivation stimulates additional plants from the roots resulting in a denser stand. Initial reseeding with grasses followed by eventual revegetation with forbs and shrubs may contribute to long-term suppression of leafy spurge. Competitive grasses include: wild rye, pubescent wheatgrass, and western wheatgrass. Burning, alone, is ineffective for reducing leafy spurge infestations, and it stimulates sprouting of established plants, increasing plant density. Spring or fall burns are best when trying to control seed production and is more effective when used in conjunction with herbicides or grazing.	Tordon Tordon + 2-4D Escort Telar Plateau Tordon Tordon + 2-4D Successful management of leafy spurge requires a long-term, extensive management plan using various combinations of management methods (IPM). Plateau, 2,4-D, Banvel or Tordon 22K systemic herbicides have been found to be effective if applied in June, when the flowers and seeds are developing, or in early to mid-September when the plants are moving nutrients downward into the roots.	2 to 3 quarts per acre + surfactant (kills) 1 quart Tordon + 1 quart 2-4D + surfactant (supresses) 1 to 1 ½ oz + 2 quarts 2,4-D per acre4D + silicone surfactant @ 1 quart per 100 gallon water 1 to 2 oz per acre4D + surfactant 8-10 oz per acre4D + surfactant ***3 Gallon Backpack*** 4.5 to 6.5 oz per 3 gallons water 2.25 oz Tordon + 2.25 oz 2-4D per 3 gallons water	during fall regrowth Plateau – Before first fall freeze
St. Johnswort *Hypericum perforatum*	St. Johnswort is a taprooted perennial weed which reproduces by seeds and short runners. The taproot may reach depths of 4 to 5 feet. Lateral roots grow 2 to 3 inches beneath the soil surface but may reach depths of 3 feet. Flowering begins in May and continues through September. Developing capsules become very sticky and contain 400 to 500 seeds. Seeds may remain viable in soil for up to 10 years..	beetle (*Agrilus hyperici*) moth (*Aplocera plagiata*) beetle (*Chrysolina hyperici*) beetle (*C. quadrigemina*) Klamath weed midge (*Zeuxidiplosis giardi*) The Klamath weed beetle has had good	Hand-pulling or digging of young, isolated plants. Repeated treatments will be necessary because lateral roots can give rise to new plants. Pulled or dug plants must be removed from the area to a refuse site or burned to prevent vegetative regrowth. Cutting and mowing not recommended - may reduce seed but promotes sprouting from rhizomes. Burning may increase the density and vigor of this species. Livestock avoid this species which can make them sensitive to sunlight, so	Tordon 2,4-D Repeated applications necessary. Metsulfuron methyl also used for this species	***Per Acre Rate*** 1 pint per acre 1 quart per acre	Pre-bloom Seedling/pre-bloom

Common & Scientific Name	Habitats; Life Cycle; & Modes of Reproduction	Biocontrol Agents	Mechanical & Cultural Methods	Herbicide Use		
				Herbicide & Method	Rate[2]	Timing
		success and another beetle (*C. Hyperici*) is better adapted to wetter sites.	grazing would select for the increase of this species. Regular cultivation. Maintain competitive, closed-canopy plant community. This species is not shade tolerant.			
Oxeye Daisy *Leucocanthemum vulgare*	Oxeye Daisy: Perennial / Shallow – rooted / Rhizomes Oxeye daisy flowers in June through August. The plant is a prolific seed producer; a single, healthy, robust plant produces up to 26,000 seeds. Reproduction occurs primarily through seed dispersal and germination, although spreading rootstalks contribute to its propagation. Seeds may be viable ten days after the flower blossoms and are dispersed close to the parent plant. Germination occurs throughout the growing season, but most new seedlings emerge in spring. Seeds that do not germinate in the spring may remain viable for many years. One study found 82 percent of seeds were viable after 6 years and 1 percent was still viable after 39 years.	No biological controls have been discovered for oxeye daisy.	Oxeye daisy should be mowed as soon as flowers appear to reduce seed production. Mowing may have to be repeated during a long growing season because mowing may stimulate shoot production and subsequent flowering. Root systems are shallow and the plant can be dug up and removed. Be sure to remove the entire root system, though, as remaining roots may produce new shoots. Hand removal will have to be continued for several years because seeds may remain viable in the soil for a long time. Where oxeye daisy is already a major member of the plant community, it will increase with continuous cattle grazing. However, oxeye daisy density may be reduced by intensive cattle grazing.	 Tordon + 2-4D Redeem Escort Curtail 2,4-D Clarity Milestone Tordon + 2-4D Redeem	***Per Acre Rate*** 1 pint Tordon + 1 quart 2-4D per acre 2 pints per acre 1 oz per acre 2 pints per acre 1 to 2 quarts per acre 1 quart per acre 4-6 oz. per acre ***3 Gallon Backpack*** 1.0 oz Tordon + 2.25 oz 2-4D per 3 gallons water 2 oz per 3 gallons water	 Before seed set
Dalmatian toadflax *Linaria dalmatica*	Perennial. A toadflax plant may have a taproot as deep as one meter. Horizontal roots may grow to several meters long (25 inches per year) and can develop adventitious buds that may form independent plants. Once established this species can suppress other vegetation mainly by intense competition for limited soil water. Mature plants are particularly competitive with winter annuals and shallow-rooted perennials. Seeds can remain dormant for up to ten years. They are quick to colonize open sites and are capable of adapting growth to a wide variety of environmental conditions. A single Dalmatian plant can produce up to 500,000 seeds, beginning in late June and continuing until September or early October. Seed production can begin on lower portions of the stems while upper portions are still in various stages of bloom. Dried floral stalks can remain standing for two years, retaining some	toadflax moth (*Calophasia lunula*) root-boring moths (*Eteobalia intermediella* and *E. serratella*) stem-boring weevil (*Mecinus janthinus*) has shown dramatic impact on Dalmatian toadflax at some locations. The following are not considered highly effective: ovary-feeding beetle (*Brachypterolus pulicarius*) flea beetle (*Longitarsus jacobaeae*)	Hand-pulling must remove all roots, best in sandy or moist soils (annually, 10-15 years to eradicate). Regular cultivation (every 7 to 10 days starting in June, for 2 years). Do not mow. Fire is not effective Toadflax seedlings are initially very vulnerable to competition from established, vigorous vegetation. Restrict spring cattle grazing on sites with toadflax to maintain vigorous competition from native species. Because of its deep, extensive root system, waxy leaf, and heavy seed production, this plant is difficult to manage.	 Tordon + 2-4D Telar Escort Escort + 2,4-D Plateau Tordon + 2-4D Telar Toadflax has a waxy leaf surface; silicone surfactant is the **MOST** important additive to any of the herbicide mixture to ensure	***Per Acre Rate*** 2 quarts per acre + surfactant 1.5 to 2.0 oz. per acre + surfactant 2 oz. per acre + silicone surfactant 1 to 2 oz Escort + 2 pints 2,4-D per acre +silicone surfactant 8 to 12 oz per/acre and MSO and silicone surfactant ***3 Gallon Backpack*** 4.5 oz per 3 gallons water + surfactant 0.5 oz per 3 gallons water + surfactant	 Spring bloom & late fall post bloom Best if Escort is used in the fall. Plateau: Fall prior to frost Spring bloom & late fall post bloom

SPECIES SPECIFIC ECOLOGY AND IPM TREATMENTS – INCLUDING HERBICIDE RATES

Common & Scientific Name	Habitats; Life Cycle; & Modes of Reproduction	Biocontrol Agents	Mechanical & Cultural Methods	Herbicide Use		
				Herbicide & Method	Rate[2]	Timing
	seeds but dispersing most during the first year. Some Dalmatian toadflax seed germination occurs in the fall, but most occurs the following spring, with peaks in April and May. Germination rates are as high as 75%, and seeds can remain dormant at least 10 years. These dormant seeds can rapidly re-infest a site following control applications, even when pre-emergent herbicides are used, because only a portion of the seeds will germinate in any given year.	seed capsule-feeding weevils (*Gymnetron antirrhini* and *G. linariae*)		results. Wet entire plant.		
Yellow toadflax *Linaria vulgaris*	Perennial Before flowering, yellow toadflax can resemble leafy spurge. It can be distinguished by snapping the stem. The absence of a milky substance in the stem will determine that the plant is a toadflax. Flowers produce capsules containing 10 to 40 seeds each. The fruit is round, about ¼ inch in diameter and brown. A single plant may produce 15,000 to 30,000 seeds. Seed germination rates are usually low, often below 10%. A toadflax plant may have a taproot as deep as one meter. Horizontal roots may grow to several meters long (25 inches per year) and can develop adventitious buds that may form independent plants. Once established this species can suppress other vegetation mainly be intense competition for limited soil water. Mature plants are particularly competitive with winter annuals and shallow-rooted perennials. Seeds can remain dormant for up to ten years. They are quick to colonize open sites and are capable of adapting growth to a wide variety of environmental conditions.	toadflax moth (*Calophasia lunula*) root-boring moths (*Eteobalia intermediella* and *E. serratella*) seed capsule-feeding weevils (*Gymnetron antirrhini* and *G. linariae*) stem-boring weevil (*Mecinus janthinus*) ovary-feeding beetle (*Brachypterolus pulicarius*) flea beetle (*Longitarsus jacobaeae*) None of these are considered highly effective.	Hand-pulling must remove all roots, best in sandy or moist soils (annually, 10-15 years to eradicate). Regular cultivation. Do not mow. Fire is not effective Intense competition with native vegetation. Because established infestations of yellow toadflax spread mainly by roots, physical removal (especially around perimeters) can limit spread.	Tordon **Tordon/Telar/Overdrive** Tordon Fall applications of picloram give partial control. Dicamba + 2, 4-D, chlorosulfuron, or metsulfuron methyl + 2, 4-D gives good control when applied before the bloom stage. 2, 4-D alone can be effective, but will likely require repeated applications.	***Per Acre Rate*** 4 pints Tordon per acre; Use a silicone surfactant 1 quart Tordon, 1 oz. Telar, & 4 oz. Overdrive; use a surfactant like LI-700 @ one quart/ac ***3 Gallon Backpack*** 4.5 oz per 3 gallons water; Use a silicone surfactant	Before seed set
Sulfur cinquefoil *Potentilla recta*	Sulfur cinquefoil is a long-lived, taprooted perennial herb that typically flowers from late May to mid July. It reproduces primarily through seed; a single plant can produce thousands of seeds annually and it can be spread by roots if they are moved by tillage or on soil-moving equipment. Seeds are dispersed primarily by wind from late summer through fall. Seeds appear to remain viable in the soil for more than four years, though studies specifically addressing seedbank persistence are lacking. In western North America, sulfur	root moth (*Tinthia myrmosae-formis*) flower-head weevil (*Anthonomus rubripes*) Sulfur cinquefoil is closely related to the desirable northern cinquefoil, the wild strawberry and tame strawberry.	Hand-pulling of small infestations (must remove root crown). Regular cultivation. Mowing not recommended. Burning used alone does not appear to be effective, and may in fact increase sulfur cinquefoil recruitment. Regular cultivation and reseeding.	Tordon + 2-4D Escort Milestone	***Per Acre Rate*** 1 pint Tordon + 1 quart 2-4D per acre 0.5 to 1 oz per acre 4-6 oz. per acre ***3 Gallon Backpack***	Before seed set and during fall regrowth

APPENDIX I
SPECIES SPECIFIC ECOLOGY AND IPM TREATMENTS – INCLUDING HERBICIDE RATES

Common & Scientific Name	Habitats; Life Cycle; & Modes of Reproduction	Biocontrol Agents	Mechanical & Cultural Methods	Herbicide Use		
				Herbicide & Method	Rate[2]	Timing
	cinquefoil invades native forest, shrub and grassland plant communities as well as disturbed habitats that typically harbor weeds. It can dominate a site within 2 to 3 years. New shoots can develop annually from the outer portion of the main root allowing a plant to live for extended periods as long as 20 years	Therefore, insects for bio control are very difficult to find for "plant specificity." (MT Dept. of Ag, 2002).	If populations are reduced (i.e. by herbicide, hand-digging), native plants are usually able to rapidly recolonize sites if sufficient native seed is still viable in the soil. Seeding of native species under adequate environmental conditions, reducing grazing pressure, and continued spot herbicide re-treatments, will result in a more rapid and stable restored native plant community.	Tordon + 2-4D Escort	1 oz Tordon + 2.25 oz 2-4D per 3 gallons water 2/10 oz per 3 gallons water	
Common Tansy *Tanacetum vulgare*	Perennial Seeds, rhizomes.	None currently available.	Hand-pulling not recommended (stimulates sprouting from rhizomes) and must remove all roots. Constant cultivation, otherwise the infestation can increase infestation by chopping roots that sprout. Mowing to reduce seed production. Grazing by sheep and goats. Revegetation for shade.	 Tordon + 2-4D Tordon Redeem + Escort Escort Tordon + 2-4D Tordon Redeem + Escort	***Per Acre Rate*** 1 pint Tordon + 1 quart 2-4D per acre 2 pints per acre 3 pints Redeem + 0.5 oz Escort per acre 1 oz per acre ***3 Gallon Backpack*** 1 oz Tordon + 2.25 oz 2-4D per 3 gallons water 2 oz per 3 gallons water 3 oz Redeem + 0.7 grams Escort	Before flowering
NEW INVADERS – CATEGORY 2 SPECIES						
Worm-wood, Absinth *Artemisia Absinthium*	This plant is very aggressive. It likes soil disturbance and will grow in most any type soils and tends to be in areas with moisture. Most common places to find absinth wormwood are gravel pits, topsoil stockpiled areas, new roads or construction sites, and irrigation ditch banks.	None currently available.	.Livestock and wildlife will not graze this plant due to the odor. The plants should be mowed in early to mid summer to promote active re-growth prior to a fall herbicide treatment.	 Redeem Tordon Milestone Redeem Tordon	***Per Acre Rate*** 1.5 to 2.0 pints per acre 2 pints per acre 6-7 oz. per acre ***3 Gallon Backpack*** 2 oz per 3 gallons water 2 oz per 3 gallons water	When the plant is at least 12 inches tall and actively growing
Orange Hawkweed *Hieracium aurantiacum*	Hawkweeds are perennials with shallow fibrous root systems and rhizomes. They can reproduce by seed or vegetatively. Orange and yellow hawkweeds also produce stolons that can produce new plants. Yellow or meadow hawkweed can also develop new plants from the root buds. Although, most populations begin from seed, these species will then aggressively spread through rhizomes or	None currently available.	Hand-pulling not recommended (stimulates sprouting from rhizomes) difficult to remove all roots. Mowing is considered ineffective. Revegetation for shade by seeding and fertilization.	 Curtail Milestone Tordon + 2,4-D	***Per Acre Rate*** 1 to 2 quarts per acre + surfactant 4-6 oz. per acre 1 pint Tordon + 1 pint 2,4-D + surfactant	Rosette to bolt

Common & Scientific Name	Habitats; Life Cycle; & Modes of Reproduction	Biocontrol Agents	Mechanical & Cultural Methods	Herbicide Use		
				Herbicide & Method	Rate[2]	Timing
	stolons. In a new site, less than 2 percent of the plants come from seedlings. Once established, vigorous stolon growth quickly expands the colony, forming dense patches with as many as 3,200 plants per square yard. Seeds are wind-adapted.			Redeem Transline (use on forest sites) After herbicide treatment, applying soluble nitrogen fertilizer can be effective in increasing the competitive abilities of grass. Fertilizing, when applied within 1 to 2 weeks of herbicide treatment is an important tool for restoring bare ground more quickly after the hawkeeds die back.	1.5 pints per acre + surfactant 1 pint per acre + surfactant	
Yellow or Meadow Hawkweed *Hieracium pratense*	Hawkweeds are perennials with shallow fibrous root systems and rhizomes. They can reproduce by seed or vegetatively. Orange and yellow hawkweeds also produce stolons that can produce new plants. Yellow or meadow hawkweed can also develop new plants from the root buds. Although, most populations begin from seed, these species will then aggressively spread through rhizomes or stolons. In a new site, less than 2 percent of the plants come from seedlings. Once established, vigorous stolon growth quickly expands the colony, forming dense patches with as many as 3,200 plants per square yard. Seeds are wind-adapted. Species of the meadow hawkweed complex are similar in appearance to orange hawkweed. The roots are shallow, fibrous and creeping. The entire plant contains a milky juice. The three species of the meadow hawkweed complex are difficult to distinguish because they interbreed. However, introduced hawkweed species can usually be distinguished from native (North American) hawkweeds. Native hawkweeds lack stolons, usually have leafy branched stems, and have an umbelliform inflorescence while the invasive species do not.	None currently available.	Hand-pulling not recommended (stimulates sprouting from rhizomes) difficult to remove all roots. Mowing is considered ineffective. Revegetation for shade by seeding and fertilization. Annual cultivation. Fertilizer (NPK) will work if there is already a large amount of native plants in the area. The fertilizer will make the native plants out-compete the meadow hawkweed complex.	Curtail Milestone Tordon + 2,4-D Redeem Transline (use on forest sites) After herbicide treatment, applying soluble nitrogen fertilizer can be effective in increasing the competitive abilities of grass. Fertilizing, when applied within 1 to 2 weeks of herbicide treatment is an important tool for restoring bare ground more quickly after the hawkweeds die back.	***Per Acre Rate*** 1 to 2 quarts per acre + surfactant 4-6 oz. per acre 1 pint Tordon + 1 pint 2,4-D + surfactant 1.5 pints per acre + surfactant 1 pint per acre + surfactant	Rosette to bolt
Dyer's woad *Isatis tintoria*	Winter annual, biennial, or short-lived perennial Seeds. Dyer's woad taproots can reach 3 to 6 feet in depth and branch laterally within the first 12 to 20 inches of soil. Seeds germinate in early spring or fall.	rust (*Puccinia thlaspeos*) [Occurs naturally, not currently approved.]	Hand-pulling, cultivation, or digging below the crown before seed production are very effective, must remove crown to prevent resprouting. Sheep grazing may also provide limited control of dyer's wood. Sheep readily consume top growth of wood until the flowering stage. Recent studies suggest that properly timed grazing, repeated	Ally or Escort (metsulfuron) (To minimize seed production on large infestations for about 2 seasons of control)	***Per Acre Rate*** ½ oz. per acre + NIS surfactant	Best in pre-bloom or early bloom. Can minimize seed production with late application after fruits have begun to form.

SPECIES SPECIFIC ECOLOGY AND IPM TREATMENTS – INCLUDING HERBICIDE RATES

Common & Scientific Name	Habitats; Life Cycle; & Modes of Reproduction	Biocontrol Agents	Mechanical & Cultural Methods	Herbicide Use		
				Herbicide & Method	Rate[2]	Timing
			several times per season may increase mortality and reduce reproductive performance when at least 60 percent of the plant is removed. Biological controls alone will not eradicate dyer's woad but may provide some control.	2, 4-D Telar (chlorsulfuon) is registered for use on right-of-ways and in crops; not in rangelands. Metsulfuron in combination with 2,4-D is effective in pastures and rangelands Picloram and dicamba provide relatively poor control of dyer's woad.	1.5-2 qts per acre 1 oz. per acre	Spring or fall rosette. Pre- or early post emergent to young plants.
Perennial peppe-rweed *Lepidium latifolium*	Perennial pepperweed produces dense stands with stems reaching up to 3 feet in height, but even up to 8 feet in wet areas. Its dense cover blocks sunlight from reaching the soil, thus suppressing the growth of other plants. Roots are enlarged at the soil surface in a woody crown and can extend at times into the water table. Roots as deep as 3 meters have been observed. The species is a prolific seed producer, capable of producing more than six billion seeds per acre. Seeds lack a hard cover, though, therefore viability may be short. Shoots flower and fruit in late spring and continue throughout much of the summer. Seeds either fall from the pod or can remain in pods until the following season. In addition to seeds, the species can spread by rhizomes which may grow to a length of ten feet.	None approved.	With the exception of continual flooding, no non-chemical treatments have been found to effectively control this species. Fall-disking, spring mowing; followed by herbicides, including glysophates has some good results. Establish and maintain healthy riparian vegetation	Telar or Escort Arsenal	***Per Acre Rate*** 1 oz/A 6 to 24 fl oz/A	Flower to bud stage
Purple loosestrife *Lythrum salicaria*	Perennial Purple loosestrife has an extended flowering season from June to September. A mature plant may have as many as thirty flowering stems capable of producing an estimated two to three million seed per year. It also readily reproduces vegetatively at a rate of about 1 foot per year. The seeds can remain viable even after 20 months of submergence in water. Seed dispersal is mainly by water, but seeds can also be transported on the feet and bodies of waterfowl and other birds, as well as numerous wetland animals. Purple loosestrife also spreads vegetatively. Root or stem segments can form new flowering stems. Muskrat cuttings and mechanical clipping can therefore contribute to rapid spread by floating in riverine and lacustrine systems.	weevil (*Hylobius transversovittatus*) black-margined and golden leaf eating beetles (*Galerucella calmariensis and G. pusilla*) flower weevil (*Nanophyes marmoratus*) The most promising control measure for purple loosestrife is the application of biological agents. Beetle species have been screened as potential control	Areas of individual younger plants and clusters of up to 100 younger plants can be hand-pulled, if done before flowering. Older plants, especially those in bogs or in deep organic soils, can be dug out. Roots of older plants can be "teased" loose with a hand cultivator. Follow-up treatments are recommended for three years after the plants are removed. Hand-pulling or cutting before seed set, followed immediately by flooding (generally, mowing or cutting not recommended). Revegetation can be effective.	Glypro Rodeo Garlon 3A Rodeo has been approved for wetlands, drainage, aquatic sites. Use only 4 lb ae/gal glyphosate formulations. Apply with an NIS approved for use in aquatic sites at 0.75% v/v. Control seedling using a 2,4-D formulation labeled for use new water. Spot application of a glyphosate herbicide to individual purple loosestrife plants is recommended treatment where	***Per Acre Rate*** 1 to 1.5% concentrate/Ac (1 to 1.5 gal/100 gal water or 1.3 to 1.9 fl. Oz. / gal) 1 to 9 lbs ai/Ac (1 to 3 gal/100 gal water)	When plants begin to flower

Common & Scientific Name	Habitats; Life Cycle; & Modes of Reproduction	Biocontrol Agents	Mechanical & Cultural Methods	Herbicide Use		
				Herbicide & Method	Rate[2]	Timing
	A strong rootstock serves as a storage organ, providing resources for growth in spring and regrowth if the aboveground shoots are cut, burned, or killed by application of foliar herbicides.	agents and are being studied.		hand pulling is not feasible. Glyphosate application is most effective when plants have just begun flowering. Timing is crucial, because seed-set can occur if plants are in mid-late flower. Where feasible, the flower heads should be cut, bagged, and removed from the site before application to prevent seed set. Since purple loosestrife is usually taller than the surrounding vegetation, application to the tops of the plants alone can be very effective and limit exposure of non-target species.		
Tall buttercup *Ranunculus acris*	Perennial with a very fibrous taproot. The bright yellow flowers are waxy, with 5 petals. Each plant is capable of producing up to 250 seeds. Tall buttercup contains a bitter juice, which cause blistering of the mouth and digestive system when consumed by livestock.		Pasture management practices that improve growth of desirable plants help to compete against emergence and growth of this plant. Also, avoid excess overgrazing by animals. Mowing fields or clipping plants close to the ground in the early spring before buttercup plants can produce flowers may help reduce the amount of seed produced, but mowing alone will not totally eliminate seed production.	 Tordon + 2-4D Redeem Escort Curtail 2,4-D Clarity Milestone Tordon + 2-4D Redeem Banvel (dicamba), WeedMaster (dicamba + 2,4-D), Redeem R&P (triclopyr + clopyralid), Crossbow (triclopyr+2,4- D), or Ally (metsulfuron) can be used in grass pastures.	***Per Acre Rate*** 1 pint Tordon + 1 quart 2-4D per acre 2 pints per acre 1 oz per acre 2 pints per acre 1 to 2 quarts per acre 1 quart per acre 4-6 oz. per acre ***3 Gallon Backpack*** 1.0 oz Tordon + 2.25 oz 2-4D per 3 gallons water 2 oz per 3 gallons water	Before seed set
Tansy ragwort *Senecio jacobaea*	Tansy ragwort is considered a biennial species. Under extremely favorable conditions, though, this species may behave like an annual. If conditions are poor or the plant is damaged, it may be induced into a mono- or polycarpic perennial habit. Polycarpic perennial plants often have large, woody rootstocks and more than one flowering stalk. Dispersal of the seed though not usually long distance (up to around 9 meters), can	Seed fly (*Pegophllemyia seneciella*) Flea beetle (*Longitarsus jacobaeae*) Cinnabar moth (*Tyria jaobaeae*)	Mowing just prior to flowering when the plant has exhausted the greatest amount of its stored reserves and before its seeds have started to develop. Although mowing can prevent flowering, it appears to increase rosette density. Hand-pulling small infestation when soil is moist and before flowering; must remove all roots. Plants must be mature enough to bloom, at which point stems are firm	 Transline 2,4-D Milestone Tordon Banvel	***Per Acre Rate*** 1 pint per acre 1 to 2 lb ae/A 4-5 oz. per acre 0.25 lb ae/A 1 lb ae/A	Rosette to bud; fall regrowth

Common & Scientific Name	Habitats; Life Cycle; & Modes of Reproduction	Biocontrol Agents	Mechanical & Cultural Methods	Herbicide Use		
				Herbicide & Method	Rate[2]	Timing
	vary depending on climatic conditions. Seeds can remain viable in the soil for several years and as deep as 25 centimeters. The species also regenerates vegetatively, usually, but not always due to damage. The whole tansy ragwort plant is poisonous. The stems contain about 25 to 50 percent of the alkaloid found in the leaves, but the flowers contain about twice as much as the leaves. Tansy ragwort has six different pyrrolizidine alkaloids, which combine and add up in the liver of herbivores over time. When these materials are transferred into pyrroles, they cause liver damage. Intoxication often happens when small plants combined with desirable forage plants are ingested unknowingly by cattle and horses while grazing. After consuming 3 to 7 percent of their body weight of this noxious weed, animals may die. If they do not die, the milk produced by them could become toxic.	Although an effective part of a long-term management strategy, the biocontrols in place will decline as the ragwort declines. Because of the ability for seed to remain dormant, they could effectively 'outwait' the decline of the biocontrol. The most effective biocontrol is when all three agents (cinnabar moth, ragwort fea beetle and seed fly) are used in combination.	and not easily broken. Because the primary root grows toward one side, the technique that works best is to tug firmly from one side and if the plant does not come out, move to the opposite side. Grazing heavy infestations with sheep prior to flowering. The healthier the native vegetation, the less likely this plant will become established (needs disturbance to create openings in native vegetation in order to establish).	Weedmaster (2,4-D + dicamba) Crossbow (triclopyr = 2,4-D) Escort clopyralid + 2,4-D Spring is usually the best time to spray. Most publications state that 2,4-D and dicamba are the most effective herbicides to use.	2 qt/A 1.5 to 2 qt/A 0.75 oz/A	
Salt Cedar *Tamarisk* complex	Perennial Seeds (can produce over 500,000 seeds); and from stems, crown and roots.	mealy bug (*Trabutina mannipara*) leaf beetle (*Diorhabda elongata*)	New growth occurs readily when young plants are grazed or mowed, or the trunk or shoots are removed or killed by fire or severe drought. Establish and maintain native vegetation.	Rodeo Aquatic Roundup Pro Arsenal Thoroughly wet foliage. Do not cut down and remove for at least 3 years or re-growth will occur.	Per Acre Rate: 71/2 Pints /Acre plus 1/2%V/V Nonionic Surfactant Spot Treatment: 11/2% V/V Solution plus 1/2% V/V Nonionic Surfactant Cut Stump Treatment: 100% V/V Solution (Full Strength) Per Acre Rate 5 QT./Acre Spot Treatment: 2% v/v solution Cut Stump Treatment: 100% v/v Solution (Full Strength) Per Acre Rate: 1.5 to 2 QT./Acre w/ MSO adjuvant Spot Treatment: 0.75 to 1% V/V solution + 0.5% surfactant Cut Stump Treatment: 12 OZ. per gallon of water	Late spring to early fall

SPECIES SPECIFIC ECOLOGY AND IPM TREATMENTS – INCLUDING HERBICIDE RATES

Common & Scientific Name	Habitats; Life Cycle; & Modes of Reproduction	Biocontrol Agents	Mechanical & Cultural Methods	Herbicide Use		
				Herbicide & Method	Rate[2]	Timing
				Garlon and Pathfinder II Garlon has been used successfully for many years, particularly as a basal treatment. Only triclopyr is effective in this type of application. Volatility of triclopyr at higher ambient temperatures could lead to undesirable effects on adjacent vegetation. Highest rates should be used where plants are mature or in dense groups; where *Tamarix* covers 60% or more of area to be treated; where plants average 15 feet tall; or under drought conditions Renovate3 (triclopyr) is labeled for aquatic use.	Foliar Treatments: 2 to 4 QT./Acre of Garlon 4 or 3A. Dilutions with diesel are not recommended. Modified Cut Stump Treatments: Undiluted Pathfinder II or 50% solution of Garlon 4 or 3A Basal Bark Treatments: Undiluted Pathfinder II or a 20 - 25% solution of Garlon 4 in natural oil or diesel. Or – 1 -3 parts Remedy plus basal bark oil	There are no timing restrictions for application of Garlon 4 or Pathfinder II. Garlon 3A should be applied during the growing season.
POTENTIAL INVADERS – CATEGORY 3 SPECIES						
Yellow starthistle *Centaurea solstitialis*	Winter annual or biennial Seeds (up to 12 years dormancy and viability). Yellow starthistle typically begins flowering in late May and continues through September, sometimes into December or later. The time period from flower initiation to the development of mature viable seed is only 8 days. Infestations can produce 50-100 million seeds per acre. Wind dispersal is not effective. Over 90 percent of seed fall within two feet of a plant. Non-pappus bearing seed can be retained in the flower head for a considerable amount of time, even into the winter. Over 90 percent of seed are germinable one week after seed dispersal. Seeds may stay viable from six to twelve years.	Approved: Rust fungus (*Puccinia jaceae var. solstitialis*) peacock fly (*Chaetorellia australis*) flower weevil (*Larinus curtus*) yellow starthistle hairy weevil (*Eustenopus villosus*)) flies (*Urophora sirunaseva* and *U. jaculata*) Effective, but pending approval: false peacock fly (*Chaetorellia succinea*)	Grazing before spine production (toxic to horses). Hard to control seed bank with mechanical methods. Hand pull small patches after plants have bolted but before they produce viable seed. Remove all above ground stem material. Unlike many invaders, it can be controlled through an intensive burning program because of its annual life cycle, however control is still difficult. Mowing, burning early in flower (timing is critical). The ideal burning time is similar to the ideal mowing time (early flowering before seedset). Unfortunately early to mid-summer burning may not be feasible in some places due to climatic or environmental conditions. It may be best used after herbicide treatment (such as with clopyralid) in the first year. This would suppress legumes and stimulate grasses making a second year fire more effective in promoting species diversity. Deep plowing may be effective where feasible because knapweed seeds will not	 2-4D Tordon Milestone Tordon + 2-4D Curtail Banvel + 2,4-D 2-4D Tordon Tordon + 2-4D Curtail Transline	***Per Acre Rate*** 2 quarts per acre 1 pint per acre 3-5 oz. per acre 1 pint Tordon + 1 quart 2-4D per ac 2 to 3 quarts per acre 1 pint Banvel + 2 pints 2,4-D per acre ***3 Gallon Backpack*** 4.5 oz per 3 gallons water 1.5 to 2 oz per 3 gallons water 1.5 oz Tordon + 2.25 oz 2-4D per 3 gallons water 4 to 4.5 oz per 3 gallons water ***Per Acre Rate*** 1 to 1 1/3 pints per acre	Actively growing (early rosette stage) in the spring, bolt to early bud, or during fall growth

APPENDIX I
SPECIES SPECIFIC ECOLOGY AND IPM TREATMENTS – INCLUDING HERBICIDE RATES

Common & Scientific Name	Habitats; Life Cycle; & Modes of Reproduction	Biocontrol Agents	Mechanical & Cultural Methods	Herbicide Use		
				Herbicide & Method	Rate[2]	Timing
			germinate below 3 cm. Shallow plowing could actually increase this species. Revegetation with native species for shade.	Redeem Transline Redeem	1.5 to 2 pints per acre ***3 Gallon Backpack*** 1.5 oz per 3 gallons water 1.5 to 2 oz per 3 gallons water	
Rush skeletonwee d *Chondrilla juncea*	Perennial Seeds, deep-rooted, rhizomatous lateral roots and root fragments. Rush skeletonweed can produce by either seed or vegetatively. It is a somewhat long lived perennial which can produce seed without fertilization. This self fertilization produces clones resulting in well-adapted biotypes that can dominate an area. Mature plants can produce 1500 flower heads with the capability of producing 20,000 seeds. Seeds can be wind dispersed up to 20 miles. Vegetative spread is possible from shoot buds found along lateral roots, and from shoot buds found near the top of the main tap root. Vegetative spread is also possible when a root fragment, as deep as four feet down, is left in the ground. When the plant stem or root is mechanically injured, vegetative growth is initiated.	Gall midge (*Cystiphora schmidti*) Gall mite (*Eriophyes chondrillae*) Rush skeletonweed rust (*Puccinia chondrillina*)	Hand-pulling must remove all roots (3 to 6 times per year for 5 to 10 years to eradicate new shoots and seedlings). Mowing not recommended (increases growth from roots). Since any mechanical damage to plats stimulates new growth resulting in satellite plants, mechanical treatment is not recommended. Frequently mowing plants infested with fall mites may decrease the rate of spread for the species. Heavy seeding rates and fertilizing with nitrogen works best.	 2,4-D + Tordon 101 Stinger Stinger + Banvel DMA Difficult to control with herbicides. Takes consistent spraying for 3 to 5 years.	***Per Acre Rate*** Tordon 101 at 1 lb/acre plus 2,4- D at 1 lb/acre 0.2 lb/acre Stinger at 0.2 lb/acre, and Banvel DMA at 1 lb/acre	 Spring
Common crupina *Crupina vulgaris*	Winter annual Wind may spread common crupina seeds up to five feet from the plant, rodents can carry seeds at least 50 feet away. Common crupina seeds can endure passage through the digestive system of cows, horses, upland game birds, and deer, but not sheep. It is not known whether or not seed passed by goats is viable. The seeds remain viable in soil for at least 25 to 32 months, so transporting soil from infested to uninfested areas can spread this weed. Inhabits many moisture and temperature regimes and soil types. Common crupina prefers well-drained, sandy or loamy soils and southern slopes on steep canyon grasslands. Also, it commonly grows along field edges, and in improved pastures, hayfields, and grass seed fields. It	None known.	Preventing all seed production for at least three generations (hand-pulling, plowing, and hoeing) on small populations. This requires that the area be checked every two to four weeks all spring and summer for at least three years following the last year the seed is produced. This prevents new plants from producing seed and extending the time required to control the infestation. Dispose of plants in a covered landfill or burn them so that mature seeds are not dispersed. After the weed has begun producing seeds, do not use mowing as a control strategy because of an increased chance of seed dissemination. Establish and maintain healthy native vegetation (must revegetate after removal).	 Transline or Stinger Tordon 2,4-D + dicamba	***Per Acre Rate*** 0.35 pt/A 0.25 to 0.50 lb ae/A 0.5 lb ae/A dicamba + 1 lb ae/A 2,4-D	 Split – fall then spring Fall or later winter Actively growing

SPECIES SPECIFIC ECOLOGY AND IPM TREATMENTS – INCLUDING HERBICIDE RATES

Common & Scientific Name	Habitats; Life Cycle; & Modes of Reproduction	Biocontrol Agents	Mechanical & Cultural Methods	Herbicide Use		
				Herbicide & Method	Rate[2]	Timing
	frequently infests gravel pits, roadsides, railroad embankments, and other rights-of-way.					
			OTHER - WEEDS			
Cheatgrass *Bromus tectorum*	Although *Bromus tectorum* can be found in both disturbed and undisturbed shrub-steppe and grasslands (e.g., where dominant grasses are bluebunch wheatgrass and Idaho fescue). The largest infestations are usually found in disturbed shrubsteppe areas, overgrazed rangeland, abandoned fields, eroded areas, sand dunes, road verges, and waste places. Winter annual Seeds	None currently available. [Two rhizobacteria, *Pseudomonas fluorescens* (strain D7), and *P. syringae* (strain 3366) are under study.]	Cutting is not recommended. Deep disking several times at intervals to bury seeds 4 to 6 inches then overseeding. Shallow disking to initiate seed germination, then either disking again or spraying with glyphosate, followed by broadcast or drill seeding. Must revegetate sites that have been disked or sprayed to provide competition. The perennial plant cover in a stand of cheatgrass is generally less than five percent. A successful weed treatment seeding would occur if the perennial species establish a groundcover of 15 to 25 percent.	Glyphosate Oust Plateau 2 to 6 oz/acre of Plateau is recommended for bare soil, with light annual brome infestation. In areas of thick vegetation and leaf litter where release is required or for use in fire breaks, higher rates of 6 to 12 oz/acre may be needed.	***Per Acre Rate*** 2 to 4 oz per acre 3 to 5 oz/acre (0.2-0.3 lb./acre) 2 oz./ acre to 12 oz./acre	Early to pre-root development. Apply in early spring when the plants are 10 cm (3.9 in) high or less and growing vigorously. Apply after fall germination Fall – pre-emergent to germination
Musk Thistle *Carduus nutans*	Does best after disturbances such as along roadsides, grazed pastures, burned areas, and old fields, but also can invade deferred pastures and native grasslands. It can occur in almost all habitats except dense forests, high mountains, deserts, and frequently cultivated farmlands. Biennial or winter annual Approximately 45 to 55 days after bolting (producing a flower stalk), musk thistles produce seeds. Fortunately, musk thistle only reproduces by seed; unfortunately, it is very prolific, producing a few thousand to 100,000 seeds per plant. On average, a plant produces 10,000 seeds. Each seed has a bristle or pappus (stiff hairs) that aids in seed dispersal; however, animals, wind, birds, and water do not generally spread the seeds; but they may. The majority falls close to the plant, resulting in thousands of new seedlings in the immediate area. Musk thistle seeds may remain viable for more than 10 years in the soil.	Rosette weevil (*Trichosirocalus horridus*) Flea beetle (*Psyliodes chalcomera*) Syrphid fly (*Cheilosia corydon*) Thistle-defoliating beetle (*Cassida rubiginosa*) [The seedhead weevil (*Rhinocyllus conicus*) is not recommended because it attacks some native thistles]	Mechanical control is effective on musk thistle. Tilling, hoeing, and hand pulling must be completed either in the rosette stage or early after the flower stalk grows (bolts), but before the plant flowers and produces seed. Hand pulling and hoeing are only an option for small stands. To be effective, a successful revegetation program must follow tilling. If this is not done, reinfestation of musk thistle is inevitable. Mowing is an option, but it can allow some musk thistle plants to recover and possibly sow seeds. Mowing does reduce seed production, but should not be the single means of control in a management program. It is most effective at the flower bud stage. Mowing combined with an herbicide is more effective. Mechanical control is very effective in ditches, yards, construction sites and pastures. However, it may be difficult or uneconomical to use this method on rangelands. Cultural control of musk thistle is limited. Good forage management practices that	Tordon + 2-4D Curtail Redeem Transline Banvel Milestone In the rosette stage, clopyralid, dicamba, picloram, and 2,4-D provide good control. Application of these chemicals is usually suggested for the fall of the first year (rosette stage). After the musk thistle bolts, metsulfuron and chlorsulfuron are effective. These two products reduce the amount of seed produced after application. Clopyralid, dicamba, picloram, and 2,4-D do not appear to reduce seed production after application if the plant has bolted. Apply metsulfuron and	***Per Acre Rate*** 1 pint Tordon + 1 quart 2-4D per acre 2 to 3 quarts per acre 1.5 to 2 pints per acre 2/3 pint per acre 1 to 1 ½ pints per acre 3-5 oz. per acre	Before seed set or during fall regrowth

APPENDIX I
SPECIES SPECIFIC ECOLOGY AND IPM TREATMENTS – INCLUDING HERBICIDE RATES

Common & Scientific Name	Habitats; Life Cycle; & Modes of Reproduction	Biocontrol Agents	Mechanical & Cultural Methods	Herbicide Use		
				Herbicide & Method	Rate[2]	Timing
			establish competitive desirable forage, maintain soil fertility, and prevent erosion will help combat musk thistle. Research shows that musk thistle has declined over the years when perennial grasses are present.	chlorsulfuron in the spring, during bolting. If the season is long and the musk thistles bolt the first year, apply metsulfuron and chlorsulfuron in the fall.		
Bull thistle *Cirsium vulgare*	Occurs in dry to moist habitats, fields, pastures, grasslands, roadways, forest clearings, rock outcrops, and along waterways. Does best in areas with moderate slope. It is not shade tolerant. Biennial Seeds (viable for 3 years or less).	gall fly (*Urophora stylata*)	Hand-pulling, mowing, burning, digging will kill if above ground portions of the plant are completely removed or consumed because it does not sprout from the root crown or root. If 8 inches or more of the stem remains alive, it may sprout from remaining portions of the stem. Revegetation for shade (the presence of tall herbs reduces bull thistle seedling survival. When grass growth is reduced by herbicide spraying, bull thistle increases in frequency.)	Tordon + 2-4D Curtail Redeem Milestone In the rosette stage, clopyralid, dicamba, picloram, and 2,4-D provide good control. Application of these chemicals is usually suggested for the fall of the first year (rosette stage). After the musk thistle bolts, metsulfuron and chlorsulfuron are effective. These two products reduce the amount of seed produced after application. Clopyralid, dicamba, picloram, and 2,4-D do not appear to reduce seed production after application if the plant has bolted. Apply metsulfuron and chlorsulfuron in the spring, during bolting. If the season is long and the musk thistles bolt the first year, apply metsulfuron and chlorsulfuron in the fall.	***Per Acre Rate*** 1 pint Tordon + 1 quart 2-4D per acre 2 to 3 quarts per acre 1.5 to 2 pints per acre 3-5 oz per acre	Before seed set or during fall regrowth
Black henbane *Hyoscyamus niger*	Disturbed open sites, roadsides, fields, waste places, and abandoned gardens. Grows best in sandy or well-drained loam soils with moderate fertility. Does not tolerate waterlogged soils. Toxic to livestock, including sheep. Annual or biennial Seeds (seeds viable for 4 years)	None currently available	Hand-pulling, movwing, or digging to prevent seed production, must remove tap root to kill the plant. Buring mature plants will kill the seed. Regular cultivation.	Tordon	***Per Acre Rate*** 1 to 2 pints per acre	Actively growing, prior to seed set
Scotch thistle *Onopordum acanthium*	Biennial Seeds	seed-head weevil (*Rhinocyllus conicus*) thistle crown-weevil (*Trichosirocalus horridus*)	Digging must cut plant off below soil level, leaving no above-ground biomass. Establish and maintain dense, vigorous native vegetation, especially important to have vegetative cover in the fall when seeds germinate (adjust grazing regimes	Tordon + 2-4D Curtail Redeem	***Per Acre Rate*** 1 pint Tordon + 1 quart 2-4D per acre 2 to 3 quarts per acre 1.5 to 2 pints per acre	Before seed set or during fall regrowth

Common & Scientific Name	Habitats; Life Cycle; & Modes of Reproduction	Biocontrol Agents	Mechanical & Cultural Methods	Herbicide Use		
				Herbicide & Method	Rate[2]	Timing
			to avoid late summer/fall rotations).	Milestone In the rosette stage, clopyralid, dicamba, picloram, and 2,4-D provide good control. Application of these chemicals is usually suggested for the fall of the first year (rosette stage). After the musk thistle bolts, metsulfuron and chlorsulfuron are effective. These two products reduce the amount of seed produced after application. Clopyralid, dicamba, picloram, and 2,4-D do not appear to reduce seed production after application if the plant has bolted. Apply metsulfuron and chlorsulfuron in the spring, during bolting. If the season is long and the musk thistles bolt the first year, apply metsulfuron and chlorsulfuron in the fall.	5-7 oz. per acre	
Perennial sowthistle *Sonchus arvensis*	Perennial Seeds (2-5 year viability), and spreading, thickened horizontal roots (rhizomes).	cyst-forming nematode (*Heterodera sonchophila*) seedhead fly (*Tephritis dilacerata dilacerata*) (waiting for final approval)	Cutting, grazing, and mowing can be effective at depleting root stores, if done selectively and frequently. Repeated hoeing and cultivating can be effective if done at 6-leaf rosette stage. Establish and maintain healthy native vegetation.	Milestone Ally or Cimarron Cimarron Max 2, 4-D, dicamba, Curtail, and glyphosate are less effective.	***Rate Per Acre*** 3-5 oz. per acre 1/10 oz DF + adjuvant 0.25 to 0.5 oz metsulfuron + 1 to 2 pt dicamba/2,4-D	
Common mullein *Verbascum thapsus*	Natural meadows and forest openings, where it adapts easily to a wide variety of site conditions. Prefers, but is not limited to, dry sandy soils. It is intolerant of shade. Primarily a weed of pastures, hay fields, roadsides, rights-of-way, and abandoned areas. Biennial or short-lived perennial Seeds (one plant can produce 100,000-180,000 seeds with viability up to 100 years).	mullein seedhead weevil (*Gymnetron tetrum*) Pending approval: mullein moth (*Cucullia verbasci*)	Easy to pull in loose soils because of shallow taproot (before flowering). Hand-hoeing or digging also effective. Mow or scythe just before flowering.	Escort Tordon + 2,4-D Tordon + Banvel Escort	***Per Acre Rate*** 1 to 1.5 oz per acre 2 pints Tordon + 2 pints 2,4-D + MSO + silicone surfactant 1.5 pints Tordon + 1.5 pints Banvel + MSO + silicone surfactant ***3 Gallon Backpack*** 1.3 grams per 3 gallons water	Rosette, before seed sets

SPECIES SPECIFIC ECOLOGY AND IPM TREATMENTS – INCLUDING HERBICIDE RATES

Common & Scientific Name	Habitats; Life Cycle; & Modes of Reproduction	Biocontrol Agents	Mechanical & Cultural Methods	Herbicide Use		
				Herbicide & Method	Rate[2]	Timing
			OTHER PLANTS - POISONOUS			
Western water hemlock (poisonous) *Cicuta douglasii*	Perennial Western hemlock is a wetland plant especially common on pastures or tilled areas. It can be found along streams and irrigation canals. Its establishment on rangeland is limited due to its high water requirement. This plant occurs in wet, fertile soils at the edge of waters. It is most common in deep loam, clay loam, or clay soils. This species is deemed the most violently toxic plant in North America. Only a small amount of the toxic substance is needed to cause poisoning in livestock and humans. The roots are the most toxic part. The leaves and stems are poisonous in the early stages of growth, but lose much of their toxicity when mature. The green seed heads are also highly poisonous. Sheep that consume it do not seem to be as affected as cattle. Grazing should be postponed until the ground is dry and the plant is harder to remove. This species is often confused for the edible water parsnip. Western water hemlock's roots are thick, fleshy tubers that contain many small chambers which can help distinguish these two species.	None currently available.	Remove it by hand pulling or hoeing. Wear gloves and protective clothing when handling these plants. Hand grubbing is very effective. The roots must be entirely removed because they are attractive to grazing livestock and highly poisonous. This plant is easily removed when the ground is moist. Gather all the plant pieces after removal and burn them.	2, 4,-D Gyphosate, 2, 4-D, or picloram There is some evidence that the toxicity of the plant increases after herbicide treatment until the plant dies. Recommend that animals be kept away from treated plants for 3 weeks after spraying.	2 lbs ae/A	Early bolt Late spring, early summer
Poison Hemlock (poisonous) *Conium maculatum)*	Perennial Poison hemlock is commonly found at lower elevations along roadsides, ditch and stream banks, creek beds, fencelines, waster places, and in or on the edge of cultivated fields where there is sufficient soil moisture. It can also invade native plant communities in riparian woodlands and flood plains where natural aquatic systems should dominate. It can survive in dry sites with poorly drained soils, but is most competitive under wetter soil conditions. All parts of poison hemlock are poisonous, but the lower sections of the stem and root are the most deadly. Poison hemlock can be distinguished from wild carrot by its hairless leaves and	defoliating moth (*Agonopterix alstroemeriana*)	Establish and maintain healthy native vegetation. Remove it by hand pulling or hoeing. Wear gloves and protective clothing when handling these plants. Plowing or repeated cultivation will prevent this species from establishing. If cultivation is not possible, mow the plants after they have bolted. Single mowing will not provide complete control. Repeated mowing will reduce its competitive ability. Burning is not considered a useful method for poison hemlock control, as this plant grows in wet sites and remains green season long.	Escort 2, 4-D Roundup or Rodeo Escort	***Per Acre Rate*** 0.75 oz/A 1 to 2 lb ae/A 1 lb ae/A ***3 Gallon Backpack*** 1.3 grams per 3 gallons water	Rosette, in spring or before seed sets

SPECIES SPECIFIC ECOLOGY AND IPM TREATMENTS – INCLUDING HERBICIDE RATES

Common & Scientific Name	Habitats; Life Cycle; & Modes of Reproduction	Biocontrol Agents	Mechanical & Cultural Methods	Herbicide Use: Herbicide & Method	Herbicide Use: Rate[2]	Herbicide Use: Timing
	stems. It is also commonly mistaken for cow parsnip, which differs in that is has palmately (fan-shaped) compound leaves rather than pinnately compound leave like poison hemlock.					
Tall Larkspur (poisonous) *Delphinium occidentale*	Perennial; tap rooted. Reinvasion and re-establishment of tall larkspur, after effective treatment, proceeds slowly due to slow growth and development of seedlings and juvenile stages. After herbicide treatment, tall larkspur may have a period of about 15 years before it again reaches potentially dangerous levels relative to livestock poisoning. Keeping cattle off herbicide treated areas until plants are completely dead and dry is recommended. Larkspur's toxicity and palatability may actually increase after the plants are sprayed. To be safe, cattle should be kept off the area for the remainder of the grazing season Livestock operators fully utilize prevention and non-chemical activities to minimize poisoning effects on permitted livestock. Herbicide methods, as addressed in this analysis, would be used in conjunction with these other activities where necessary or appropriate. The following outline prevention measures that can be taken for tall larkspur management: • Authorized entry dates are delayed until tall larkspur maturity level is increased and toxicity is decreased. • A special salt formulation (i.e. "silent herder") can be utilized by permittees to help minimize loss from tall larkspur poisoning. • Moving livestock through tall larkspur populations slowly and with full stomachs can be utilized by permittees.	None currently available.	Use of ammonium sulphate fertilizer to control patches of tall larkspur is another method available (cutting to ground level and applying 1/2 cup to base of each tall larkspur, cutting to 10 inch height and applying ¾ cup at the base of each tall larkspur, or no cutting and applying one cup at the base of each tall larkspur). For spot treatment, there are advantages for using ammonium sulfate fertilizer compared to herbicide treatment. They include: • The fertilizer is granular so it is easy to pack into areas of difficult access or rough terrain. • The fertilizer can be purchased at any local feed store. • There is no requirement for a certified applicator. • The application method is simple and easy to learn. • The cost of application is less than the cost of the application of herbicides. • As with herbicide control, larkspur mortality occurs within one year and continues for many years. • With the addition of a weed eater, the application rate can be reduced by up to 50%, which could ultimately lead to a cost savings. • Areas cut with a weed eater die the same season they are treated, allowing for grazing to occur in the immediate area without further threat of livestock loss from poisoning. • Application of the fertilizer does not appear to adversely affect nearby vegetation in the area.	2,4-D Clarity Tordon Escort Metsulfuron Triclopyr is also known to control tall larkspur. Glyphosate (Roundup) can be selectively applied by hand spraying or with a wipe-on applicator to kill larkspur in the bud stage. It, however, is not as effective after the plants have flowered. Use of ammonium sulfate fertilizer to control patches of tall larkspur is another method. Cut to ground level and apply 1/2 cup to base of each tall larkspur, or cut to 10 inch height and apply ¾ cup at the base of each tall larkspur, or no cutting and applying one cup at the base of each tall larkspur	***Per Acre Rate*** 2 quarts per acre 1 quart per acre 1 quart per acre 0.8 to 1.6 oz per acre 0.9 oz ai per acre	Rosette to bolt Tordon: Throughout growing season Escort: Early stages of growth (less effective as larkspur matures) Metsulfuron: Maximum vegetation but prior to flowering

APPENDIX I
SPECIES SPECIFIC ECOLOGY AND IPM TREATMENTS – INCLUDING HERBICIDE RATES

Common & Scientific Name	Habitats; Life Cycle; & Modes of Reproduction	Biocontrol Agents	Mechanical & Cultural Methods	Herbicide Use		
				Herbicide & Method	Rate[2]	Timing
OTHER PLANTS – TOTAL VEGETATION CONTROL						
Total Vegetation Weed Control	Use in areas needing total vegetation removal, such as paved road shoulders, well pads, helibases, etc. Repeat application is generally necessary every 1-2 years.	N/A	N/A	Diuron + Oust Diuron / Karmex Diuron: Refer to label for use in irrigation ditches. Higher rates needed for perennial grasses and broadleaf weeds. Deep rooted perennials will require retreatment. Use glyphosate for initial knock-down of vegetation, then followup later in the season for total vegetation control with diuron. Oust: Do not spray near water. See Label	***Per Acre Rate*** 8 lbs. Diuron + 3 oz Oust 8 to 10 lbs per acre	

Disclaimer: The information in this material is for guideline purposes. The recommendations contained are based on the best available knowledge at the time of printing. Any reference to commercial products, trade or brand names is for information only, and no endorsement or approval is intended. The authors do not guarantee or warrant the standard of any products referenced or imply approval of the product to the exclusion of others which also may be available. All pesticides listed are registered for suggested uses in accordance with federal laws and regulation as of the date of printing. If the information does not agree with current labeling, follow the label instructions. The label is the law. Warning! Pesticides if misused, can be dangerous. Read and follow all instructions and safety precautions on labels. Carefully handle and store Pesticides in originally labeled containers out of the reach of children, pets and livestock. Dispose of empty containers immediately in a safe manner and place. Contact your state Department of Agriculture (or similar regulatory agency) for current regulations.

APPENDIX J
HERBIDICE EFFICACY
ADJUVANTS, WATER QUALITY, NOZZLES, TEMPERATURE, & RAINFASTNESS

SPRAY ADJUVANTS & WATER QUALITY[1]

Postemergence herbicide effectiveness depends on spray droplet retention and herbicide absorption by weed foliage. Adjuvants and spray water quality influence postemergent herbicide efficacy.

Surfactants and Adjuvants

Adjuvants are spray solution additives, and are considered to be any product added to an herbicide solution to improve the performance of the spray mixture. Spray adjuvants consist of surfactants, oils and fertilizers. The most effective adjuvant will vary with each herbicide, and the need for an adjuvant will vary with environment, weeds present, and herbicide used. Adjuvant use should follow label directions and be used with caution as they may increase injury to crops or reduce weed control. An adjuvant may increase weed control from one herbicide but not from another. Comparisons of adjuvants should be made at marginal control levels to determine the effectiveness of adjuvants for specific herbicides, sprays, water and weeds. Effective adjuvants will enhance herbicides at reduced rates and provide consistent results under adverse conditions. However, reduced rates exempt herbicide manufacturers from liability for nonperformance.

Examples of adjuvants include compatibility agents (used to aid mixing two or more herbicides in a common spray solution), drift retardants (used to decrease the potential for herbicide drift), suspension aids (used to aid mixing and suspending herbicide formulations in solution), spray buffers (used to change the spray solution acidity), and surfactants.

Surfactants (surface active agents) are a type of adjuvant designed to improve the dispersing/emulsifying, absorbing, spreading, sticking and/or pest-penetrating properties of the spray mixture. Pure water will stand as a droplet, with a small area of contact with the waxy leaf surface. Water droplets containing a surfactant will spread in a thin layer over a waxy leaf surface.

Because postemergence herbicide effectiveness is greatly influenced by plant factors such as age, size and the growing conditions encountered before application, herbicide performance can vary. A way to minimize the variations in postemergence herbicide performance is to use an adjuvant or surfactant in the spray solution. Adjuvants, specifically surfactants, generally improve the effectiveness of postemergence herbicides. Typically, surfactants are not added to herbicides that are soil applied (pre-emergence).

The surfactants listed below are categorized into groups or classes based on their chemical composition and how they work. Generally, five surfactant classes are recognized. Table K-1 lists their general usage.

TABLE K-1: SURFACTANT CLASS AND GENERAL USAGE

Surfactant Class	General Usage
non-ionic surfactants (NIS)	all purpose
crop oil concentrates (COC)	used primarily with grass herbicides
nitrogen-surfactant blends	used primarily with broadleaf herbicides
esterified seed oils	all purpose
organo-silicones	all purpose

Non-ionic surfactants are comprised of linear or nonyl-phenol alcohols and/or fatty acids. This class of surfactant reduces surface tension and improves spreading, sticking and herbicide uptake.

Crop oil concentrates are composed of a blend of paraffinic-based petroleum oil and surfactants. This surfactant class reduces surface tension and improves herbicide uptake and leaf surface spreading.

Nitrogen-surfactant blends consist of premix combinations of various forms of nitrogen and surfactants. They generally are used with herbicides recommending the addition of ammonium sulfate or 28 percent nitrogen. These surfactants reduce surface tension and improve leaf surface spreading.

Fertilizers containing ammonium nitrogen have increased the effectiveness of herbicides like glyphosate, and 2, 4-D amine. Fertilizer applied with other herbicides may reduce weed control or cause crop injury. Some fertilizers enhance non-target plant growth to stimulate competition from weed species re-establishing. Fertilizers should be used with herbicides only as indicated on the label or where experience has proven acceptability. Ammonium sulfate is effective for tall larkspur control on its own, as outlined in chapter 3.

---

[1] Miller et. al., 1998 and NSDU 1999.

ADJUVANTS, WATER QUALITY, NOZZLES, TEMPERATURE, & RAINFASTNESS

Esterified seed oils are produced by reacting fatty acids from seed oils (corn, soybean, sunflower, canola) with an alcohol to form esters. The methyl or ethyl esters produced by this reaction are combined with surfactants/emulsifiers to form an esterified seed oil. These surfactants reduce surface tension and improve herbicide uptake by improving herbicide distribution on the leaf surface.

Oils generally are used at one gallon per 100 gallons of spray solution) or at 1 to 2 pints per acre depending on herbicide and oil. Oil adjuvants are petroleum, vegetable, or methylated vegetable or seed oils (MSOs) plus an emulsifier for dispersion in water.

Organo-silicones are usually silicone/surfactant blends of silicone to non-ionic or other surfactants; a few within this classification are composed entirely of silicone. These surfactants provide a tremendous reduction in surface tension and spread more than conventional surfactants. In addition, this class of surfactant provides improved effectiveness through maximum rainfastness.

TABLE K-2. SURFACTANT TYPE BY HERBICIDE

Herbicide (Examples of common brands)	Recommended[2] adjuvant *types*, for the herbicides listed in this analysis
2,4-D (many brands)	Most brands recommend adding a nonionic surfactant; may be mixed with a nitrogen fertilizer or crop oil concentrate
Aminopyralid	Nonionic surfactant
Clopyralid (Transline®, Stinger®)	Nonionic surfactant
Diuron	Nonionic surfactant
Glyphosate (RoundUp Original®)	Adjuvants already added; nonionic surfactant or ammonium sulfate may also be added
Glyphosate (RoundUp Ultra®)	Adjuvants already added; ammonium sulfate may also be added
Glyphosate (Rodeo®, Aquamaster®, Glypro®)	*Nonionic surfactant*
Hexazinone (Velpar L®)	No recommendations on label
Imazapic (Plateau®)	Methylated seed oil or crop oil concentrate; nonionic surfactant; silicone-based surfactant; fertilizer-surfactant blends
Imazapyr (Arsenal®)	Methylated seed oil or crop oil concentrate; nonionic surfactant; silicone-based surfactant; fertilizer-surfactant blends
Picloram (Tordon 22K®)	Nonionic surfactant
Triclopyr (Garlon 3A®, Garlon 4®)	Nonionic surfactant

TABLE K-3. SURFACTANT CLASS, PRODUCT, AND PRODUCT MANUFACTURER.

Surfactant Class	Product Name[3]	Manufacturer
non-ionic surfactant (NIS) – (See Table K-4 for more available NIS products.)	Activator 90 Penetrate II Triton Ag 98 X-77	United Ag Products Wilfarm Rhône-Poulenc United Ag Products
crop oil concentrates (COC)	Agri-Dex (99:1) Crop Oil Plus (83:17) Prime Oil (83:15)	Helena Wilfarm Terra
nitrogen-surfactant blends	Cayuse Plus (surfactant + AMS) Chaser (surfactant + 28% N) Dispatch (surfactant + 28% N) Patrol (surfactant + 28% N)	Wilfarm Terra United Ag Products Helena
esterified seed oils	Hasten Meth-Oil MSO Sun-it II	Wilfarm Terra United Ag Products Cyanamid
organo-silicates	Sylgard 309 (straight silicone) Silwet L-77 (straight silicone) Kinetic (silicone/surfactant blend) Herbex (silicone/surfactant blend)	Wilfarm United Ag Products Helena American Colloid

[2] Recommended from herbicide labels. Be sure to always follow the label instructions for specifics on choosing and mixing herbicides and adjuvants.
[3] Including but not limited to these surfactants. No endorsement is intended, nor is any criticism implied of similar products not mentioned.

TABLE K-4. NONIONIC SURFACTANTS[4]
Suggested use rate of 2 pints/100 gallons unless noted[5]

Product	Supplier	Product	Supplier
Activate Plus	Riverside	Maxisurf 90	T-Tech
Activator 90	Loveland Industries	Motion	Loveland Industries
Active 80	Walker Distributing	Neptune	Loveland Industries
Ad-Here XL	Simplot	Pen-A-Tratell	Precision Labs
Ad-Wet 90	Simplot	Penetrate II	Farmland
Adspray 80	Helena	Penetrex	Midsouth Chemical Co.
Advance 90	Countrymark Cooperatives, Inc.	PHT Spray-Ad 90	Simplot
Alliance 90	Countrymark Cooperatives, Inc.	Premier 90	VanDiest Supply Co.
American Spreader	VPG	Premium 80	Big Rivers
APSA 80	Amway	Purity 100	Rosen's Inc.
Aquagene 90	Universal Cooperatives	R-11	Wilbur-Ellis/Wilfarm
Baron	Estes, Inc.	RP 80/20 Surfactant	Red Panther
Bio-88	Kalo, Inc.	S-80/20	T-Tech
Bio Surf	Loveland Industries	Saturall 60	Conklin
Boost	Precision Labs	Saturall 85	Conklin
Century	Precision Labs	Satruate	Walker Distribution
ChemSurf	United Suppliers	Silkin	Riverside
ChemSurf 80	Chemorse	Silwet L-77	Loveland Industries
ChemSurf 90	Chemorse	Spray Activator 85	VanDiest Supply Co.
ChemSurf 90	United Suppliers	Spray Fuse 90	Combelt Chemical Co.
Chemwett Plus	Coastal Chemical Corp.	Spreader 80	Loveland Industries
CLASS Preference	Cenex/Land O'Lakes Agronomy	Spreder-Sticker	Lesco
CLASS Spraybooster S	Cenex/Land O'Lakes Agronomy	Spret	Helena
Cohort DC[6]	Helena	Super Surf 90	Cleveland Chemical Co.
Co-op Spreader-Sticker	Farmland	Surf-Ac 820	Drexel
Escort 100	Walker Distributing	Surf-Aid	Riverside
Freeway	Loveland Industries	Surf-King Plus	Estes, Inc.
Galactic	Custom Chemicides	Surfactant 80	Estes, Inc.
Herbraid Plus	Walker Distributing	Sylgard 309	Wilbur-Ellis/Wilfarm
Impact	Chemrose	Tradition 93	Rosen's Inc.
Induce	Helena	Tronic-98	Kalo
Inspray 90	Brandt Colsolidated	Unifilm 707	Custom Chemicides
Kenetic[7]	Helena	Widespread	Loveland Industries
Kinetic HV	Helena	X-77	Loveland Industries
Latron Ag-98	Rohm and Haas	X-90	Cornbelt Chemical Co.
Low Foam Surfactant	Cleveland Chemical Co.	80-20 Surfactant	Universal Cooperatives
M-90	The McGregor Company	80-20 Surfactant	Johnston-Locke Co.
Maxi-Surf	T-Tech	80-20 Surfactant	Cannon

Non-ionic Surfacant Approved for use in Water

Only Aquamaster, Glypro, Rodeo, and some 4 lb ae/gal formulations of glyphosate can be applied on water because they do not include adjuvants that are toxic to fish and aquatic life. For any herbicide used in and around water, add only approved surfactants for effective weed control. Some surfactants labeled for use in and around water are: Activate Plus, Agridex, Class Act NG, Induce, Liberate, LI-700, Preference, R-11, Widespread, and X-77.

Some water pH modifiers are used to lower (acidify) spray solution pH because many insecticides and some fungicides breakdown under basic conditions (high water pH). Most solutions are not high or low enough in pH for important herbicide breakdown in the spray tank. pH reducing adjuvants (example: LI-700) are sometimes recommended for use with herbicides because of greater absorption of weak acid type herbicides when the spray solution is acidic. However, low pH is not essential to optimize herbicide absorption. Many herbicides are formulated as various salts which are absorbed as readily as the acid. Salts in the spray water may antagonize these formulated salt herbicides. In theory, acid conditions would convert the herbicide to an acid and overcome salt antagonism. However, herbicides in the acid form are less water soluble than in salt form. Formation of herbicide acid with pH modifiers may precipitate and plug nozzles when solubility is exceeded, such as with high rates in low water volumes. Antagonism of herbicide efficacy by spray solution salts can be overcome without lowering pH by adding AMS or, for some herbicides, 28% liquid nitrogen fertilizer.

In summary, adjuvants that are designed specifically to reduce pH generally are not required for herbicide efficacy. The type of acid or components of buffering agents and the specific herbicide all need to be considered before using pH modifying agents.

---

[4] Source: Bussan, et al, 2001-2002
[5] Always follow the herbicide label for surfactant use.
[6] Use at 28 oz./100 gal.
[7] Use at 1 pt./100 gal.

APPENDIX J
HERBIDICE EFFICACY
ADJUVANTS, WATER QUALITY, NOZZLES, TEMPERATURE, & RAINFASTNESS

Choosing adjuvants with herbicides: Several herbicides allow use of nonionic surfactant, petroleum oil additives, methylated seed oil (MSO) additives, and nitrogen fertilizer. Questions about adjuvant selection are common. MSO type additives have often given greater weed control than petroleum oil additives and nonionic surfactants (NIS) but cost up to 2 to 3 times more. The added cost of MSO's and increased risk of crop injury when used at high temperatures have deterred people from using this class of adjuvants.

Some herbicide labels restrict use of oil adjuvants and recommend only the use of NIS alone or combined with nitrogen based fertilizer solutions. Follow label directions for adjuvant selection. Where labels allow use of oil additives, a petroleum oil based adjuvant referred to as crop oil concentrates (COC) or methylated seed oil (MSO) adjuvants may be used. The following are conditions where MSO type additives may give greater weed control than other adjuvant types:

Conditions that favor use of MSO type adjuvants

- Low humidity, hot weather, lack of rain, and drought stressed weeds or weeds not actively growing due to some condition causing stress.
- Herbicides used at reduced rates.
- When university data supports use. Only some herbicides give greater weed control when used with MSO type adjuvants. Glyphosate should never be used with an oil adjuvant because glyphosate is very water soluble (water + oil do not mix) and the added cost of an MSO is not necessary.

Adjuvant use in low gallonage spray volumes

Many herbicides may be applied in low spray volumes by aircraft. In certain instances, spray adjuvant rates should be adjusted upward for low sprayer volumes.

Some herbicide labels contain information on adjuvant rates for different spray volumes. Additional recommendations to assure sufficient adjuvant load would be to determine the adjuvant rate on an area basis.

DYES

It is recommended that dyes be mixed with the herbicide so applicators can see which plants have been treated and if they have gotten any herbicide on themselves or their equipment. Some pre-mixed herbicides include a dye (e.g., Pathfinder II® includes the active ingredient triclopyr, a surfactant, and a dye). Ester based herbicides like Garlon 4® require oil-soluble dyes like colorfast purple®, colorfast red®, and basoil red® (for use in basal bark treatments), which are sold by agricultural chemical and forestry supply companies.

SPRAY CARRIER WATER QUALITY

Minerals, clay, and organic matter in spray carrier water can reduce the effectiveness of herbicides. Clay inactivates glyphosate. Organic matter inactivates many herbicides and minerals can inactivate 2, 4-D amine, dicamba, and glyphosate.

Water in many parts of the United States is high in sodium bicarbonate which reduces the effectiveness of 2, 4-D amines (not esters), glyphosate, and dicamba. The antagonism is related to the salt concentration. At low salt levels, loss in weed control may not be noticeable under normal environmental conditions. However, antagonism from low salt levels will cause inadequate weed control when weed control is marginal because of drought or partially susceptible weeds.

High salt levels in spray water can reduce weed control in nearly all situations. Calcium and, to a lesser degree, magnesium are antagonistic to 2, 4-D amine, dicamba, and glyphosate.

Water often contains a combination of sodium, calcium, and magnesium, and these cations generally are additive in the antagonism of herbicides. Many adjuvants are marketed to modify spray water pH, but low pH does not appear essential to the action of most herbicides.

SPRAY AND VAPOR DRIFT

Drift-Reducing Nozzles: Several sprayer nozzles designed to reduce spray drift are available. These nozzles increase spray droplet size and reduce the number of small droplets. These drift-reducing nozzles are flat-fan types and are adapted for conventional spray equipment. The two primary types of drift-reducing nozzles are pre-orifice and veturi designs.

Pre-orifice nozzles: The two most common are the Drift Guard and Turbo TeeJet nozzles from Spraying Systems Co. Pre-orifice nozzles regulate the liquid flow rate prior to the exit orifice and cause a pressure drop within the nozzle so fewer fine spray droplets are produced. Drift Guard nozzles are available in 80 and 110 spray angles with a recommended pressure range of 30 to 60 psi. The Turbo TeeJet combines the pre-orifice technology with a turbulence chamber to produce a wide-angle flat-fan spray pattern that greatly reduces the amount of spray in fine droplets. Turbo TeeJet nozzles are available in 11001 to 11008 sizes with a spray pressure range of 15 to 90 psi although pressures below 30 psi are recommended to maximize average droplet size and drift reduction.

Venturi (Air induction) nozzles. These include the AI TeeJet from Spraying Systems Co.; the TurboDrop and TurboDrop XL from Greenleaf Technologies Inc.; the Lurmark Ultra-Lo-Drift from Precision Fluid Control Products; the Spraymaster Ultra from Delavan Spray Technologies, and the Lechler ID from Hardi. Although each nozzle has a distinct design, the technology is basically the same. Each includes a pre-orifice to regulate the flow rate so a large exit orifice can be used to produce the spray pattern. Additionally, venturi nozzles include an air-induction assembly that incorporate air into the liquid stream thereby forming air-filled spray droplets. The design allows air-filled droplets to shatter upon impact thus improving spray coverage and retention of the large droplets. A spray pressure of 40 psi will maintain a good spray pattern but pressures greater than 60 psi result in the most consistent performance of herbicides. The air-induction system operates more efficiently at higher spray pressures and in contrast to standard flat-fan nozzles, the droplet size spectrum of venturi nozzles is not greatly influenced by this pressure change.

Drift reduction. Research at NDSU has shown the greatest reduction in spray drift with venturi type nozzles or Turbo TeeJet nozzles operated at low pressure (20 psi). Drift Guard nozzles significantly reduce drift compared to a standard flat-fan nozzle but produce a quantity of fine droplets that result in greater spray drift than venturi or Turbo TeeJet nozzles. The following table compares droplet size data for various sprayer nozzles.

TABLE K - 5. NOZZLE DROPLET SIZE COMPARISON

Nozzle	Pressure	% spray vol.	VMD*
	(psi)	(<191 microns)	(microns
Extended Range 8002	40	65	154
Drift Guard 8002	40	32	292
Turbo TeeJet 11002	40	32	271
Turbo TeeJet 11002	15	19	393
TurboDrop 11002	60	10	520

*VMD = volume median diameter = diameter in which 50% of the spray volume is in droplets smaller than, not an average droplet size.

Percentage of small spray droplets (<191 microns) is the best indicator relating to spray drift. Venturi nozzles (TurboDrop) produced the largest spray droplets and the fewest number of fine spray droplets compared to other nozzles. The data in the table also illustrates the importance of using low spray pressures to maximize the drift-reducing potential of Turbo TeeJet nozzles.

Sufficient spray coverage to maintain effective weed control is a common concern of using nozzles that produce large spray droplets. In most situations, coverage is adequate. Total spray coverage will decrease as droplet size increases, but the number of drops delivered to the target weed will generally still is sufficient for excellent weed control with drift-reducing nozzles.

TABLE K - 6. SPRAY VOLUME PER DROPLET DIAMETER

	Spray Volume		
Spray Droplet Diameter	5 gpa	10 gpa	20 gpa
(microns)	— drops per square inch ---		
200	720	1440	2880
300	214	428	856
400	90	180	360
500	46	92	184

Even at 5 gpa spray volume, nozzles that produce large spray drops up to 500 microns in diameter will theoretically produce 46 drops/sq. inch, which should be adequate to cover even small target weeds. Research at NDSU supports this premise as herbicides applied at 2.5 gpa spray volume with drift-reducing nozzles provided weed control similar to herbicides applied with standard flat-fan nozzles.

Large spray droplets may bounce off leaves upon impact resulting in poor droplet retention. The concern is legitimate if applying herbicides without adjuvants. Spray adjuvants applied with herbicides improve droplet retention and deposition. NDSU research has found that spray retention is similar for drift-reducing nozzles and standard nozzles when herbicides were applied with NIS or MSO type adjuvants.

For maximum drift control without affecting herbicide performance, use venturi type nozzles at more than 60 psi or Turbo TeeJet nozzles at less than 30 psi. Contact herbicides, hard-to-wet weed species, and small target weeds are examples where drift-reducing nozzles may reduce herbicide performance. Weed control with drift reducing nozzles may be better than with conventional nozzles when environmental conditions favor lateral droplet movement. Always read the label as some herbicide labels place restrictions on the spray application equipment or spray volume/acre that can be used.

HERBICIDE EFFICACY - TEMPERATURE AND RAINFASTNESS

SPRAYING TEMPERATURES

Foliar treatments are most effective when the herbicide is applied to actively growing foliage. Weeds growing during prolonged cool weather or under droughty conditions do not actively translocate herbicides and thus require a higher rate of application than do weeds that are actively growing. Ideal temperatures for applying most post-emergence herbicides are between 60 and 85 degrees F. Speed of kill may be slow when temperatures remain below 60 F. Some herbicides may injure non-target species if applied above 85 F or below 40 F. At temperatures above 85 degrees F, the risk of vapor drift from certain herbicides such as 2, 4-D esters, dicamba, or triclopyr is much greater.

Avoid applying volatile herbicides such as 2,4-D ester and dicamba during hot weather, especially near susceptible broadleaf crops, shelterbelts, or farmsteads. Glyphosate is not susceptible to UV light but research has shown reduced weed control if glyphosate is applied after 4:00 pm or before 10:00 am. 2, 4-D, dicamba, Stinger, and glyphosate (resistant crops) have adequate non-target species safety and provide similar weed control across a wide range of temperatures, but weed death is slowed when cold temperatures follow application.

Temperatures following herbicide application influence non-target species safety. Cold temperatures may affect non-target species safety and weed control from herbicides. Plants metabolize herbicides, but metabolism slows during cool or cold conditions, which extends the amount of time required to degrade herbicides in plants. Rapid degradation under warm conditions allows non-target species to escape herbicide injury. Herbicides may be sprayed following cold night-time temperatures if day-time temperatures warm to at least 60 degrees (NDSU 2005).

HERBICIDE STORAGE TEMPERATURES[8]

Herbicides may be exposed to freezing temperatures in storage. The following information gives the minimum storage temperature of some herbicides to avoid risk of reduced herbicide activity.

TABLE K – 7. STORAGE RESTRICTIONS

Restriction	Herbicide
No storage temperature restriction	Wettable powders and granules, as a rule, are not affected by low temperatures. These formulations should be stored in a dry place as moisture may promote caking or lead to certain chemical changes that reduce their effectiveness.
Do not store below 32 F	Redeem, Stinger, Tordon 22K, Velpar.
Do not store below 20 F	Plateau, Weedar 64
Do not store below 10 F	Arsenal, glyphosate, Rodeo, Roundup

Minimum storage temperature refers to the temperature required to keep the pesticide in solution. Below that temperature, the pesticide will form crystals and freeze. The freezing point of many pesticides is lower than 32 degrees due to the hydrocarbon solvents or inert ingredients. Pesticides that cannot be frozen must be placed in a heated or adequately insulated area to avoid sub-zero temperatures.

Before storing pesticides for the winter, read the label. While care was taken to assure the accuracy of the above table, labels continue to be amended. Therefore, they should always be consulted.

RAINFASTNESS. The term "Rainfastness" refers to the time needed between application and rainfall/snow event to avoid significant reduction in efficacy. Rainfall shortly after application of most post-emergent herbicides may reduce weed control. Effect will vary with product, the interval between spraying and rainfall and the intensity and duration of the rainfall. The guidelines outlined in the following tables are based on label information. Refer to the specific product

[8] NDSU 2005 and MSU Extension Service, 1995.

labels for rainfastness information. Use the longest time interval on the component products when considering tank mixes.

Rainfall shortly after post-emergent herbicide application reduces weed control because herbicide is washed off the leaves before absorption is complete. See rainfast interval tables below. Dew at application may reduce weed control if spray, in combination with dew, runs off the leaf surface. If no spray run-off occurs after application, weed control may be equal or greater than if no dew was present at application.

TABLE K – 8. EFFECT OF RAINFALL ON HERBICIDE EFFICACY[9]

Required Interval	Product
1 hour	Plateau. Roundup UltraMax/ Roundup WeatherMax
2 hours	Milestone
4 hours	Accent, Ally + 2,4-D Amine, 2,4-D Amine, Cimmarron, Clarity4, Escort
6 hours	Curtail M, Tordon 22K, Rodeo, Redeem, Roundup/glyphosate

[9] NDSU 1999

- End of Appendix J -

APPENDIX K
CALIBRATIONS, CALCULATIONS, & CONVERSIONS

SPRAYER CALIBRATIONS AND CALCULATIONS[1]

TABLE K - 1. SPRAYER CALIBRATIONS AND CALCULATIONS

Calculation	Example	Formula
1. Determining the Gallon per Minute (GPM) required of nozzles to achieve a given Gallon per Acre (GPA)	**Example 1** You want an output of 20 GPA. Your nozzles are 20 feet apart. Your field speed is 5 MPH. How much do you need to collect from each nozzle to achieve 20 GPA? $\frac{20\text{ GPA} \times 5\text{ MPH} \times 20}{5940} = \frac{2000}{5940}$ = 0.336 GPM per nozzle **Example 1a - Convert Gallons per Minute (GPM) to Ounces per Minute (OPM)** From Example 1 you have collected 0.336 GPM from each nozzle. 0.366 x 128 = 43 OPM per nozzle **Example 1b - Convert OPM to GPM** You have collected 43 OPM from each nozzle. 43 OPM / 128 = 0.336	**Formula 1** $GPM = \frac{GPA \times MPH \times W}{5940}$ GPM = Gallons per minute from one nozzle GPA = Gallons per acre W = nozzle spacing (inches) or; = spray width (inches) if using a broadjet or; = row spacing (inches) divided by the number or nozzles per row. MPH = Field speed in Miles Per Hour 5940 = a constant **Formula 1a** OPM = GPM x 128 **Formula 1b** GPM = OPM / 128
2. Determining GPA when given nozzle GPM, spacing between nozzles and field speed	**Example 2** Nozzle spacing = 20". Field speed = 5 MPH. You collected liquid from all of the nozzles for one minute and obtained an average of 51 ounces per nozzle. Convert 51 OPM to GPM 51 OPM / 128 = 0.398 or 40 GPM per nozzle. $\frac{0.398\text{ GPM} \times 5940}{5\text{ MPH} \times 20} = \frac{2364.12}{100}$ = 23.64 or 24 GPA	**Formula 2** $GPA = \frac{GPM \times 5940}{MPH \times W}$
3. Determining required speed when you know GPA, GPM and spacing between nozzles or broadjet swath	**Example 3a** Nozzle output = 10 GPM. Swath width = 35 feet (420 inches). Desired GPA = 30 GPA. What speed do you need to be traveling to achieve 30 GPA? $\frac{10\text{ GPM} \times 5940}{30\text{ GPA} \times 420} = \frac{59{,}400}{12{,}600}$ =4.7 or 5 MPH ******Broadjet Example: If you had nozzles that were 20 inches apart and GPM was 0.40 GPM, the answer would be 3.96 or 4 MPH.* **Example 3b** You want 30 GPA with a field speed of 7 MPH and nozzle spacing is 30 inches. Using formula #1, you determine that you need to collect 1 GPM from each nozzle. When you check the nozzles, the output is actually 1.5 GPM. You can either change the nozzles or adjust your field speed to achieve 30 GPA. $\frac{1.5\text{ GPM} \times 5940}{30\text{ GPA} \times 30\text{ inches}} = \frac{8{,}910}{900}$ = 9.9 or 10 MPH as the new field speed	**Formula 3** $\frac{GPM \times 5940}{30\text{ GPA} \times 420}$
4. How much area can my sprayer cover (acres)?	**Example 4** Your sprayer is calibrated at 30 GPA. You have a sprayer with a 500 gallon tank. How many acres can you treat with 500 gallons? How many can you treat with 250 gallons? $\frac{500\text{ gallons}}{30\text{ GPA}}$ $\frac{250\text{ gallons}}{30\text{ GPA}}$ = 16.6 acres treated = 8.3 acres treated	**Formula 4** $\frac{\text{Volume in tank}}{GPA}$ = Acres Treated
5. How much total solution do you need in order to spray a given acreage?	**Example 5** You want to spray 10 acres and your sprayer is calibrated to 25 GPA. How much total solution do you need in your sprayer tank? 10 acres x 25 GPA = 250 gallons	**Formula 5** Acres to spray x GPA = Gallons required
6. How much pesticide, dry or	**Example 6a** Your sprayer can treat 30 acres and the label calls for a rate of 1 pint	**Formula 6**

[1] Montana State University Extension Service, 2000. MontGuide MT 2000-14

Calculation	Example	Formula
liquid, do you add to the tank when rate is given on a per acre basis?	per acre. How much pesticide do you add to the tank? 30 acres x 1 pint = 30 pints or 3 ¾ gallons (30 / 8 pints per gallon) **Example 6b** Using the information in Example 6a, you are using dry ingredients in ounces per acre. How much pesticide do you add to the tank to treat 30 acres? 30 acres x 10 ounces = 300 ounces or 18 ¾ pounds (300 / 16 oz. per pound)	Acres treated x labeled rate = Amount of pesticide to add to the tank
7. How much liquid pesticide do you add to the tank when the rate is given according to pounds of active ingredient (a.i.) per acre?	**Example 7a** A rate of 3 lbs/acre of the active ingredient (a.i.) is recommended. This pesticide contains 8 lbs. of a.i. per gallon of formulation. 3 lbs. per acre / 8 lbs. a.i. per gallon = 0.375 gallons per acre ***or*** 1 ½ quarts per acre (0.375 x 4) ***or*** 3 pints per acres (0.375 x 8) **Example 7b** You have calibrated a 300 gallon sprayer. It can spray 7.5 acres per tank at 40 GPA. A recommendation indicates to apply ½ pound a.i. per acre. The label indicates that it contains 2 pounds of a.i. per gallon. How much pesticide will you add to the tank to spray 7.5 acres? $\frac{\text{0.50 lb a.i./acre}}{\text{2 lb a.i./gallon}}$ = 0.25 gallon (1 quart)/ac 7.5 acres/tank x 1 quart per acre = 7.5 quarts	**Formula 7** $\frac{\text{Labeled Rate Per Acre}}{\text{Amount of a.i. per gallon}}$ = Gallon amount to apply
8. How much dry pesticide do you apply per acre when the rate is given as a percentage of a.i.?	**Example 8** A recommended rate of 0.2 lbs. a.i./acres of a 25% wettable powder (WP) is recommended (One pound of formulation contains 0.25 lbs. a.i.) $\frac{\text{0.2 lbs. per acre}}{\text{0.25 lbs. a.i.}}$ = 0.80 lb formulation /ac To convert to ounces: 0.80 lbs. x 16 ounces/lbs. (dry) = 12.8 ounces per acre	**Formula 8** $\frac{\text{Recommended rate}}{\text{\% a.i. per lbs of formulation}}$ = lbs. of formulation/acre
9. Check the output of boom nozzles.	All nozzles across a boom need to be applying roughly the same amount of liquid within a certain error range (usually 5% on either side of the average). Clean and/or replace any nozzles that fall outside of your given error range. **Example 9** You have a 10 nozzle boom and you have collected from under each nozzle for one minute. You noted the following nozzle outputs Nozzle =1 2 3 4 5 6 7 8 9 10 Output (Oz)=43 44 47 42 46 44 50 41 42 42 = 441 oz. Total Average Nozzle Output = 441 oz. / 10 nozzles = 44.1 oz. For 5% error: 44.1 oz. x 0.05 = 2.2 oz. to add and subtract from the average. Error range (5%) on either side of the average = 41.9 oz. to 46.3 oz. Nozzles 3, 7, & 8 needs to be cleaned or replaced. Note: If a nozzle's output is lower, it may be plugged and only need to be cleaned. Repeat this exercise until all nozzles fall with the error range.	**Formula 9** $\frac{\text{Nozzle 1 output + nozzle 2 output + etc.}}{\text{Number of nozzles on the boom}}$ = Average Nozzle Output Average Nozzle Output x 0.05 = amount to add and subtract from the Average Nozzle Output to make an error range of 5%.
10. Adding Adjuvants to the Spray Tank	Pesticide labels often suggest adding adjuvants to the spray mix, listing the rate of the adjuvant in terms of percentage of the spray mix, volume per acre, or volume per quantity of spray mix **Example 10a – When the rate is expressed as a % of the spray mix** Total spray mix = 500 gallons. Adjuvant rate is 1% of the finished spray volume. 0.01 x 500 = 5 gallons of adjuvant added along with pesticide to make a 500 gallon solution **Example 10b – When the rate is expressed as a volume per acre.** Your sprayer is calibrated to 30 GPA and you plan on using 300 gallons of solution. An adjuvant calls for a rate of 1 pint per acre. 300 gallons / 30 GPA = 10 acres x 1 pint per acre = 10 pints of adjuvant added along with pesticide to make a 300 gallon solution.	**Formula 10a** $\frac{\text{\% of spray mix x gallons of spray mix}}{100}$ = Gallons adjuvant needed **Formula 10b** Adjuvant needed = Adjuvant rate x acres to be treated **Formula 10c** Adjuvant needed = $\frac{\text{Rate per 100 gallons}}{100}$ x gallons of spray mix

<table>
<tr><th>Calculation</th><th>Example</th><th>Formula</th></tr>
<tr><td></td><td>Example 10c – When the rate is expressed in quarts per 100 gallons.
Adjuvant rate = 2 quarts per 100 gallons. A total of 400 gallons of spray mix will be used.

$\frac{2\ \text{quarts}}{100\ \text{gallons}} \times 400$ gallons total mix

= 8 quarts of adjuvant to add along with pesticide to make a 400 gallon solution.</td><td></td></tr>
<tr><td>11. Dilution Rule</td><td>Example 11
How much of a 50% concentrate is needed to make 100 gallons of a 1.5% spray?

50 x Volume 1 (V1) = 1.5 x 100;
V1 = 3 gallons

The final mixture (Volume 2 or V2) is the amount of the concentrate (V1) plus the required amount to make up to V2. If V1 = 3 gallons and the required amount is 100 gallons, add 97 gallons of water to 3 gallons of concentrate.</td><td>Formula 11

C1 x V1 = C2 x V2

C1= % of a.i. in concentrate
V1 = quantity of concentrate needed
C2 = % a.i. desired in final mixture
V1 = quantity of final mixture

It is important that the units used are all the same: i.e. percent x pounds = percent x pounds or percent x volume = percent x volume</td></tr>
<tr><td>Hints on Percentage Mixing</td><td>A pesticide label may tell you to mix up a concentration or percentage of the product in water. For example, mix 1 part of the pesticide concentrate and 99 parts water. This makes a 1 percent mixture. Since there are 128 fluid ounces in one gallon, 1.28 ounces of a concentrate mixed into 1 gallon of water will make approximately a 1 percent mixture (Hint: 1 tablespoon is about ½ ounce.)

The label may also instruct you to make a spray solution with a specific percentage of active ingredient (a.i., for example, a one percent a.i. solution for a particular pest. If the pesticide is formulated as an emulsifiable concentrate (EC) containing 57 percent active ingredient. To make a 1 percent a.i. spray solution from this formulation, you would add 1 part of the pesticide to 56 parts of water.</td><td></td></tr>
<tr><td>Glyphosate product rates based on formulation, acid equivalent (ae) and active ingredient (ai).[2]</td><td>Pounds ae/gal or ai/gal are found on glyphosate product labels. The following table displays conversions.

<table>
<tr><th>lb ae</th><th>lb ai</th><th>0.38 ae</th><th>0.57 ae</th><th>0.75 ae</th><th>1.125 ae</th><th>1.5 ae</th></tr>
<tr><th></th><th></th><th colspan="5">fl oz/A</th></tr>
<tr><td>3</td><td>4</td><td>16</td><td>24</td><td>32</td><td>48</td><td>64</td></tr>
<tr><td>4</td><td>5.4</td><td>12</td><td>18</td><td>24</td><td>36</td><td>48</td></tr>
<tr><td>4.7</td><td>5.1</td><td>12</td><td>18</td><td>24</td><td>36</td><td>48</td></tr>
<tr><td>4.5</td><td>5.5</td><td>11</td><td>16</td><td>22</td><td>32</td><td>44</td></tr>
<tr><td>5</td><td>6.1</td><td>10</td><td>15</td><td>20</td><td>30</td><td>40</td></tr>
</table></td><td></td></tr>
</table>

[2] NDSU 2005

HAND-HELD / BACKPACK SPRAYER CALIBRATION

TABLE K - 2. BACKPACK SPRAYER CALIBRATION

No Math Version[3]		
Step 1	Establish a calibration plot that is exactly: 18.5 feet wide x 18.5 feet long	
Step 2	Spray the calibration plot uniformly with water, noting the number of seconds required:	Time Required to spray plot = ________ seconds.
Step 3	Spray into a bucket for same number of seconds.	
Step 4	Measure the number of ounces of water in the bucket:	Volume sprayed = __________ ounces
Step 5	The number of ounces collected from the bucket is equal to the number of gallons per acre the sprayer is delivering:	Gallons Per Acre (GPA) = __________
Adding the Correct Amount of Herbicide to Tank for Liquid Herbicide Formulations		
Step 6	Record sprayer output in gallons/acre (calculated from Step 5).	Output (volume) = __________ GPA
Step 7	Determine volume of full spray tank.	Tank volume = ________ gallons
Step 8	From the herbicide label determine amount of herbicide concentrate to apply per acre.	__________ Herbicide per Acre (quarts or pints)
Step 9	Determine the amount of herbicide to add to each gallon using the chart below.	
Step 10	Calculate the amount of herbicide to add to each tank.	__________ Amount of herbicide/gallon x __________ number of gallons in a tank = __________ Total amount of herbicide to add to a tank.

The following table can be used to determine the amount of pesticide, liquid or dry formulation, needed per unit area (i.e. gallons per acre or GPA) to give the rate recommended for effective control[4].

TABLE K - 3. AMOUNT OF HERBICIDE TO ADD TO MEET RECOMMENDED HERBICIDE RATE/ACRE BASED UPON SPRAY AMOUNT (GPA) CALIBRATED[5]

Gallons / Acre (GPA)	1 pint	1 quart	2 quarts	3 quarts	4quarts
15	6 tsp	2 fl oz.	4 fl oz.	6.25 fl oz.	8.5 fl oz.
20	5 tsp	10 tsp	3.25 fl oz.	4.75 fl oz.	6.33 fl oz.
30	3 tsp	6 tsp	2 fl oz.	3.25 fl oz.	4.25 fl oz.
40	2.33 tsp	4.75 tsp	1.66 fl oz.	2.33 fl oz.	3.25 fl oz.
50	2 tsp	3.75 tsp	1.25 fl oz.	2 fl oz.	2.5 fl oz.
60	1.66 tsp	3.25 tsp	6.33 tsp	1.66 fl oz.	2 fl oz.
70	1.33 tsp	2.75 tsp	5.5 tsp	1.33 fl oz.	1.75 fl oz.
80	1.25 tsp	2.33 tsp	4.75 tsp	7.25 tsp	9.5 tsp
90	1 tsp	2 tsp	4.25 tsp	6.33 tsp	8.5 tsp
100	1 tsp	2 tsp	3.75 tsp	5.75 tsp	7.66 tsp
120	0.75 tsp	1.5 tsp	3.0 tsp	4.75 tsp	6 tsp

Liquid Conversions
3 teaspoons = 1 tablespoon
8 fl ounces = 1 cup
2 tablespoons = 1 fluid ounce
1 cup = 16 tablespoons

---

[3] Montana State University Extension Service, 2000. MontGuide MT 2000-14
[4] Source: Bussan, et al, 2001-2002
[5] tsp = teaspoons
TBS = tablespoons
fl oz. = fluid ounces

Example: Assume that the calibration of your sprayer (Steps 1 – 5) yields an output of 30 GPA and your sprayer holds 3 gallons. Your herbicide label for the target weed species indicates a herbicide application rate of 1 pint/acre. Go to the chart and read across from 30 Gal. / A to the 1-pint column – the amount of herbicide to add per gallon is 3 tsp in the chart. Since your sprayer holds 3 gallons of total solution, you would add 9 tsp of herbicide in addition to the water in each tank.

HAND-HELD SPRAYERS[6]

Hand-held sprayers are often used for spot treating patches of weeds or for treating small areas such as lawns. Spray coverage should be uniform and the leaves of the target plants should be wet but the amount of spray solution applied should be limited so that run-off does not occur. Hand-held sprayers should be calibrated by 1) spraying a known area using water and a standard and reproducible procedure, 2) measuring the amount of water applied, and 3) calculating gallons per acre (gpa).

For example, 0.75 gallon on 500 sq ft is the same as 65 gallons per acre:

43,560 sq ft per acre / 500 sq ft x 0.75 gallon = 65 gpa.

The desired rate in lb/A or pt/A can be used to calculate the amount of herbicide to add to the spray solution. If 3 pt/A is desired:

3 pt/A / 65 gpa = 0.046 pt or 0.73 fl oz or 1.5 Tbsp/gal of spray solution (16 fl oz = 1 pt, 2 Tbsp = 1 fl oz).

When calibration of a hand-held sprayer is not possible and the herbicide being used is safe to the environment and non-target plants, a volume of 50 to 70 gpa can be assumed. However, the actual volume applied can vary considerably with the type of sprayer, spray pressure, and technique of the applicator so calibration is strongly encouraged.

Some herbicide labels specify a percent solution for use in hand-held sprayers. The following chart provides mixing instructions to obtain solutions of varying percent concentrations on a volume/volume basis:

TABLE K - 4. VOLUME / VOLUME (V/V) BASIS

	%Concentration of Herbicide				
Desired Solution Volume	**0.5**	**1.0**	**1.5**	**2.0**	**5.0**
gallons	Amount of herbicide to add, **fl oz**				
1	0.6	1.3	1.9	2.6	6.4
2	1.3	2.6	3.8	5.2	12.8
5	3.2	6.4	9.6	12.8	32.0
10	6.4	12.8	19.2	25.6	64.0
100	64.0	128.0	192.0	256.0	640.0

1 pt = 16 fl oz
1 Tbls = 3 tsp
1 Tbls = 15 ml

16 Tbls = 1 cup
1 fl oz = 30 mls
1 fl oz = 2 Tbls

ACTIVE INGREDIENT (A.I.) VERSUS ACID EQUIVALENT (A.E.)

Labels on herbicide containers and instructions for mixing herbicides sometimes use units of herbicide active ingredient (a.i.) or acid equivalent (a.e.). The herbicide may be sold in different concentrations, but units of a.i. or a.e. provide standard measures, so the mixing instructions can apply in all cases. In order to follow these instructions, you will need to determine how many a.i. or a.e. are in an ounce, or quart or liter, of the concentrate on hand.

The "active ingredient" (a.i.) of an herbicide formulation is responsible for its herbicidal activity or ability to kill or suppress plants. The a.i. is always identified on the herbicide label by either its common name or chemical name, or both. Herbicide formulations available for sale commonly contain other so-called "inert" compounds too.

[6] NDSU 2005.

The "acid equivalent" (a.e.) of an herbicide is just the acid portion of the a.i., and it is this acid portion that is responsible for herbicidal effects. The acid portion (or parent acid) is generally associated with other chemical compounds to form a salt or an ester, which is more stable and better able to move through a plant's waxy cuticle, and into the plant. The salt or ester is the a.i.

Weak acid herbicides are formulated as salts or esters through the addition of a salt or ester molecular group to the parent acid molecule. This allows the herbicide acid to mix properly with adjuvants and enhances the compound's ability to move into plant tissue. Once the herbicide enters the plant, the salt or ester group is cleaved off the parent molecule, allowing the acid to affect the plant.

Because the salt or ester molecular group can vary dramatically in size, a measure of the percent a.i., especially in the case of a weak acid herbicide, does not adequately reflect the percentage of acid in the formulation. Thus, the a.e. is used to determine the amount of the product to be applied.

Product labels for weak acid herbicides will list the product's percentage of active ingredient, as well as other inert ingredients, at the top of the label. The percentage of acid equivalent in the formulation is usually listed below these percentages in a separate table or paragraph.

TABLE K - 5. PINTS OF COMMERCIAL PRODUCT NEEDED PER ACRE

Pounds a.i./gallon of commercial product	Pounds of active ingredients per acre					
	1/4	1/2	1	2	3	10
1.0	2	4	8	16	24	80
2.0	1	2	4	8	12	40
3.0	2/3	1 1/3	2 2/3	5 1/3	8	26 2/3
3 .34	3/5	1 1/5	2 2/5	4 4/5	7 1/5	24
4.6	1/2	1	2	4	6	20
6.0	1/3	2/3	1 1/3	2 2/3	4	13 1/3

AQUATIC WEED CALCULATIONS

Some herbicides, such as those for control of emergent plants, are applied on the basis of the area to be treated. Others, such as those used to control certain submerged weeds, are applied on the basis of the volume of water to be treated. For aquatic weed control, the volume of water and/or area to be treated must be determined accurately. Chemical application rates are provided on the label in either an amount to apply per surface acre or per acre-foot of water. One acre is a surface area measurement of 43,560 square feet. An acre-foot is one acre of water one foot deep. To determine acre-feet of water, multiply the surface area in acres by the average depth in feet.

TABLE K – 6. SURFACE AREA CALCULATIONS

AREA DESCRIPTION	EXAMPLES
CIRCLE = 3.14 x radius^2	EXAMPLE: a pond radius 85 feet x 85 x 3.14 = 22686.5 square feet total surface area (/ 43,560 = 1/2 acre surface area)
RECTANGLE = length x width	EXAMPLE: a pond length 145 feet x width of 75 feet = 10,875 square feet total surface area (/ 43,560 = 1/4 acre surface area)
TRIANGLE = (base x height) / 2	EXAMPLE: a pond base of 100 feet x height of 50 feet = 5,000 square feet / 2 = 2,500 square feet total surface area (/ 43,560 = 1/10 acre surface area)
OVAL = length x width x 0.8	EXAMPLE: ■ pond length of 200 feet x width of 90 feet x 0.8 = 14,400 square feet total surface area (/ 43,560 = 1/3 acre surface area)

CONVERSION FACTORS

Liquid Conversion Factors

1 gallon = 4 quarts or 8 pints or 3,785 cc or 128 fluid ounces
1 quart = 2 pints or 4 cups or 946 cc or 32 fluid ounces
1 pint = 2 cups or 473 cc or 16 fluid ounces
1 cup = 16 tablespoons or 236.5 cc or 8 fluid ounces
1 tablespoon = 3 teaspoons or 15 cc or 0.5 fluid ounces
2 tablespoons = 1 fluid ounce

Weight Conversion Factors

1 pound = 16 ounces or 454 grams
1 ounce = 28.4 grams or 30 cc

Plot Size Factors

1 rod = 16.5 feet
1 square rod = 16.5 X 16.5 feet or 272 square feet
1 acre = 160 square rods
1 acre = 43,560 square feet

Application Factors

1 cup per square rod = 10 gallons per acre
1 pint per square rod = 20 gallons per acre
1 quart per square rod = 40 gallons per acre
1 gallon per square rod = 160 gallons per acre

TABLE K - 7. METRIC CONVERSIONS[7]

Symbol	When you know	Multiply by	To Find	Symbol
lb	pounds	0.45	kilograms	kg
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
oz	ounces	30.0	milliliters	ml
A	acres	0.4	hectares	ha
ha	hectares	2.5	acres	A

[7] Conversions in this metric guide are pounds per acre to kilograms per hectare
Example: 2 lb/A to kg/ha = 2 x 0.45 = 0.90 kg/A x 2.5 = 2.25 kg/ha

TABLE K - 8. COMMON UNIT CONVERSIONS AND ABBREVIATIONS

Multiply...	By...	To Get...
Acres	0.4047	Hectares (ha)
Acres	4047	Square Meters (m2)
Acres	4840	Square Yards
Acres	43,560	Square Feet
Cubic Feet	1728	Cubic Inches
Cubic Feet	0.037	Cubic Yards
Cubic Feet	7.481	Gallons
Cubic Feet	59.84	Pints
Cubic Feet	29.92	Quarts
Cups	8	Ounces
Cups	16	Tablespoons
Cups	48	Teaspoons
Gallons	3.785	Liters (L)
Gallons	128	Ounces
Gallons	8	Pints
Gallons	4	Quarts
Gallons per Acre (gal/acre)	9.34	Liters per Hectare (L/ha)
Grams (g)	0.001	Kilograms
Grams (g)	1000	Milligrams
Grams (g)	0.035	Ounces (oz)
Grams per Liter (g)	1000	Parts per Million
Hectares (ha)	2.47	Acres
Inches (in)	2.54	Centimeters (cm)
Kilograms (kg)	1000	Grams (g)
Kilograms (kg)	35.274	Ounces (oz)
Kilograms (kg)	2.2046	Pounds (lb)
Kilograms per hectare (kg/ha)	0.892	Pounds per Acre (lb/acre)
Kilometers (km)	0.6214	Miles (mi)
Liters (L)	1000	Cubic Centimeters (cm3)
Liters (L)	0.2642	Gallons (gal)
Liters (L)	33.814	Fluid Ounces (oz)
Meters (m)	100	Centimeters
Meters (m)	3.281	Feet
Meters (m)	0.001	Kilometers
Meters (m)	39.37	Inches
Meters (m)	1.094	Yards
Miles (mi)	1.609	Kilometers (km)
Miles (mi)	5280	Feet
Miles (mi)	1760	Yards
Miles per Hour (mi/hr)	44.70	Centimeters per Second (cm/sec)
Miles per Hour (mi/hr)	88	Feet per Minute
Miles per Hour (mi/hr)	1.467	Feet per Second
Miles per Minute	88	Feet per Second
Miles per Minute	60	Miles per Hour
Milligrams (mg)	0.000035	Ounces (oz)
Milliliters (ml)	0.0338	Ounces (oz)
Ounces (oz) - dry	0.063	Pounds
Ounces (oz) - liquid	0.063	Pints
Ounces (oz) - liquid	0.031	Quarts
Ounces (oz) - liquid	480	Drops
Ounces (oz) - liquid	29.573	Milliliters (ml)
Ounces (oz) - liquid	0.02957	Liters
Ounces (oz) - liquid	29.5735	cubic centimeters (cm3)
Ounces (oz)	2	Tablespoons
Ounces (oz)	6	Teaspoons
Ounces (oz)	28.3495	Grams (g)
Ounces per acre (oz/acre)	70.1	Grams per Hectare (g/ha)
Ounces per Acre (oz/acre)	0.0701	Kilograms per Hectare (kg/ha)
Parts per Million	0.001	Grams per Liter
Parts per Million	0.05842	Grains per Gallon
Parts per Million	1	Milligrams per Liter
Parts per Million	0.0001	Percent
Parts per Million	1	Milligram per Kilogram
Pints	0.125	Gallons
Pints	0.473	Liters
Pints	2	Cups

APPENDIX K
CALIBRATIONS, CALCULATIONS, & CONVERSIONS

Multiply...	By...	To Get...
Pints - liquid	16	Ounces - liquid
Pints - liquid	0.5	Quarts - liquid
Pounds (lb)	16	Ounces
Pounds (lb)	0.01	Hundredweight (CWT)
Pounds (lb)	453.6	Grams (g)
Pounds (lb)	0.4536	Kilograms (kg)
Pounds per acre (lb/acre)	1.121	Kilograms per hectare (kg/ha)
Pounds per acre (lb/acre)	112.1	mg/square meter (mg/m2)
Pounds per acre (lb/acre)	11.21	µg/square centimeter (µg/cm 2)
Pounds per gallon (lb/gal)	119.8	grams per liter (g/L)
Pounds per gallon (lb/gal)	7.48052	Pounds per Cu. Foot
Quarts	2	Pints
Quarts	0.25	Gallons
Quarts	0.946	Liters
Quarts – liquid	32	Ounces - liquid
Quarts – liquid	2	Pints - liquid
Square centimeters (cm2)	0.155	Square inches (in2)
Square centimeters (cm2)	0.0001	Square meters (m2)
Square meters (m2)	10,000	Square centimeters (cm2)
Tablespoons	3	Teaspoons
Tablespoons	0.5	Ounces - liquid
Teaspoons	60	Drops
Teaspoons	0.33	Tablespoons
Teaspoons	0.1666	Ounces - liquid
Tons	907.185	Kilograms
Yards	0.9144	Meters

Note: All references to pounds and ounces refer to English units of measurement unless otherwise specified.

TABLE K – 9. BAND WIDTH (FT) DISTANCE REQUIRED TO TREAT ONE ACRE

Band width (ft)	Feet	Miles
1	43,560	8.25
2	21,780	4.13
3	14,520	2.75
4	10,890	2.06
5	8,712	1.65
10	4,356	0.8

- End of Appendix K -

APPENDIX L
MAINTENANCE, CLEANING AND STORAGE OF SPRAYERS

MAINTENANCE, CLEANING AND STORAGE OF GROUND SPRAYERS[1]

Proper maintenance and storage techniques not only streamline the following year's preseason preparations, but also enhance sprayer performance while adding years to its productive life.

Long-term exposure to many pesticides that pass through a sprayer can corrode and deteriorate sprayer parts, paint and electrical connections. The residue from these products may be harmful to anyone working on or around the machine. Also, trace amounts of pesticides lodged in sprayer parts may damage crops if carried over to the next spraying season.

Your personal safety and that of your family, employees and your crops make it important that you thoroughly clean and decontaminate your sprayer during the season, between crops and before you store it for the winter.

A complete maintenance and storage process consists of six steps: Read, Rinse, Drain, Clean, Inspect, and Store.

Read. Read before you begin cleaning your sprayer, be sure to review the label of the pesticides you've applied. The label will:

- Tell you how to properly dispose of residual product.
- Provide any special cleaning instructions that might be necessary.
- Recommend decontaminating products.
- Outline the Personal Protective Equipment (PPE) you need to safely clean your sprayer.

Rinse. The goal of rinsing is to remove any concentrated or large areas of the product that might still be in or on the sprayer.

Cleaning spray equipment involves circulating water through the whole system and then applying it to a site that is listed on the label of the pesticides you have used. Several rinses using a small volume (up to 10 percent of the spray tank capacity) are better than merely filling the spray tank once with clean water. Select a location where the rinsate will not contaminate water supplies, streams, crops or other plants and where large puddles won't accumulate, creating a hazard to humans, animals and the environment.

Preferably, the area should be impervious to water and have a wash rack or cement apron with a sump to catch contaminated wash water and pesticides.

Make sure that you drain the spray tank in a manner consistent with the pesticide label. Don't just open the valves and let it pour on the ground.

Add larger volume nozzle tips for a faster and legal method to dispose of sprayer rinsate.
The outside of the sprayer should also be washed. For this purpose, applicators are encouraged to have a source of water on the sprayer in order to rinse down the sprayer in the field on a regular basis. Again, when rinsing the sprayer, do not create standing puddles that might be accessible to children, pets, livestock or wildlife.

Drain. To dispose of pesticide rinsate in accordance with label directions, apply the rinsate to a site where the products are to be used originally. In other words, the site must be listed on the label. Repeat the draining process after decontaminating and re-rinsing the sprayer. Drain any clean water rinse tanks prior to storage to avoid damage caused by water freezing inside.

Clean. After the sprayer has been rinsed and drained, then clean or decontaminate it.
Be sure to decontaminate both the interior and exterior of the machine, running liquid through the boom structure and out the nozzles. There is no need to fill the sprayer. Use only enough cleaning solution to completely fill the lines and provide enough agitation. There may be a need to scrub or power wash the inside of the tank. Wear personal protective equipment (PPE).

Select cleaning agents based on the pesticide and formulation used (see Table below).

---

[1] MT State University Extension Service, 2003. MontGuide #8917. http://www.montana.edu/wwwpb/pubs/mt8917.html

APPENDIX L
MAINTENANCE, CLEANING AND STORAGE OF SPRAYERS

TABLE L – 1. CLEANING SOLUTIONS

Pesticide Used	25 Gallons Cleaning Solution	2.5 Gallons Cleaning Solution	Instructions
Hormone herbicides, ester form.(2,4-D, brush killers, dicamba)	1 Qt. household ammonia	1/2 cup household ammonia	Agitate solution 10-15 minutes, flush small amount through system and let remainder stand overnight. Flush and rinse with clean water.
	OR	OR	
	2 lb. trisodium phosphate	1/4 lb.trisodium phosphate	Same as above except let stand for at least 2 hours.
	OR	OR	
	1/2 lb. fine activated charcoal + 1/2 cup powder detergent*	2 tablespoons fine activated charcoal and 1-2 oz. powder detergent	Agitate; operate sprayer for 2 min., let remainder stand for 10 min., then flush through sprayer. Rinse with clean water.
Hormone herbicides, ester form. (2,4-D, brush killers)	1 lb. washing soda (sal soda) + 1 gal kerosene + 1/4 lb. powder detergent*	4 oz. washing soda (sal soda) +1 1/2 cups kerosene + 1 Tablespoon powder detergent*	Rinse inside of tank and flush small amount through system. Let stand at least 2 hours. Flush and rinse with clean water
Other herbicides	1/4 lb. powder detergent*	1 Tablespoon powder detergent*	Rinse with clean water before and after using sudsy solution.

*Liquid detergent may be substituted for powder detergent; mix at rate to make a sudsy solution.

Cleaning agents should penetrate and dissolve pesticide residues and allow them to be removed when the rinsate is removed from the sprayer. Commercial tank cleaning agents and detergents help remove both water- and oil-soluble herbicides and are recommended on many pesticide labels.

Some tank cleaning agents and ammonia solutions raise the pH of the rinsate solution, making some products such as sulfonylurea (SU) herbicides more water soluble and thus easier to remove from internal sprayer parts.

Chlorine bleach solutions hasten the breakdown of SU's and some other herbicides into inactive compounds. However, chlorine is less effective at dissolving and removing SU herbicide residues from spray tanks than ammonia solutions. Never add chlorine bleach to ammonia or liquid fertilizers containing ammonia, because the two materials react to form toxic chlorine gas.

Fuel oil or kerosene is effective for removing oil-soluble herbicides such as esters and emulsifiable concentrates. The fuel oil or kerosene should be followed by a detergent rinse to remove the oily residue. Also run cleaning solution throughout the sprayer, including the agitation system and the return lines. Then rinse the system with clean water. Open all nozzles until they are spraying pure water.

Inspect. After the final rinse you can inspect your sprayer and make the necessary repairs and modifications.

Even though the sprayer has been "cleaned," always wear personal protective equipment. Some residue may remain on and in the sprayer.

Here is a checklist of what to look for both during and after cleaning:

- Mismatched and worn nozzles
- Damaged nozzle screens
- Damaged strainer screens
- Cracks, leaks and overall performance in the pump.
- Hose condition, especially brittleness or cracks
- Valve condition, identifying any possible leaks or areas where seals may have loosened
- Boom structure, identifying any cracks that must be fixed

Modifications

Some modifications might include:

- Shut-off valves on either side of the pump to facilitate pump removal and repair
- Shut-off valves at the boom
- Shut-off valves at the tank
- Additional pressure gauges
- Installing flowmeters
- Installing tank level indicators

- By-pass and agitation lines
- Engine-kill switches
- Additional lines to aid in cleaning, i.e. broadjets for spraying out rinsate as opposed to using boom

6. Store

Now that the sprayer has been thoroughly cleaned, you may want to remove parts of it that may be damaged during storage.

- Remove strainers (filters) and wash them by hand with soapy water (remember to wear chemical-resistant gloves), rinse them and either store them or place them back in the sprayer.
- Pay special attention to nozzles, nozzle bodies and check valves. Chemical residue can build up in these areas and harden over winter, dramatically reducing the sprayer's performance next season.
- Remove nozzle tips, screens, check valves, caps and nozzle bodies from the nozzle body assemblies. Correctly plug the assemblies.
- Clean and rinse out the nozzle tips, nozzle bodies and check valves. Store in a marked container. Store check valves at room temperature over the winter to avoid damage that can be caused by freezing temperatures.
- Remove all pressure gauges and cap the openings on the sprayer. Store the gauges where they are not subjected to freezing or damage.

Finally, circulate antifreeze through the sprayer and all plumbing, including booms, valves, manifolds, flowmeters and agitation/return lines. Allow the antifreeze to circulate through the boom's hoses. This will coat the hose linings to prevent drying out and cracking. Capping all boom nozzles will help retain the antifreeze in the system, but you may need to open one or two nozzles to allow the antifreeze to circulate through the boom. Cap those nozzles when antifreeze has completely filled the system.

The goal for the storage phase is for the antifreeze to push out residual water that may be in the system and to coat all of the sprayer's components. Allow the antifreeze to sit in the pump and valves to avoid rusting and damage that can be caused by moist air being trapped in the system. Since some applicators remove the pump prior to storage, the installation of shut-off valves on either side of the pump can facilitate this process.

Anti-freeze for recreational vehicles (RV's) is commonly used for storage of agricultural sprayers. Unlike automotive antifreeze, it is less toxic to animals. While many RV antifreeze products will gel in extremely cold conditions, they should not freeze. Regardless, always read the antifreeze label to make sure it will perform under your winter conditions.

Once the sprayer has been cleaned, decontaminated and winterized, it is ready to be stored. Obviously, indoor storage, away from the abuse of the elements, is preferable. But any indoor site should be far away from both liquid and dry fertilizers. The dust and residue from these products can corrode both paint and hardware on the sprayer.

If there is a spray monitor, remove the display pad from the cab and store it in a warm, dry place.

FOAM MARKERS AND FLOWMETERS

Cleaning and winterizing sprayers includes the foam marker system and any flowmeters. Start with the marker system. Disassemble the foam generators, then clean residue from the mixing filters and screens using clean water and the appropriate cleaning solution. Consult the manufacturer's instructions of the foam marker to determine if specialized cleaning solutions are needed.

By not cleaning out the spongy mixing filter, the residual foaming agent may harden, making it nearly impossible to clean later.

To clean the flowmeter, follow procedures outlined in the manufacturer's instructions. Otherwise, use the following procedure where applicable. One should determine if any warranties are affected.

- Disconnect the wiring harness from the electrical connector on the sensor.
- Unscrew the flowmeter insert and remove.
- Clean insert with clean, soapy water. Make sure the turbine turns easily. If it doesn't, clean again.
- Reinstall insert in flowmeter.
- Attach electrical connector to sensor.

APPENDIX L
MAINTENANCE, CLEANING AND STORAGE OF SPRAYERS

MAINTAINING SPRAYER EQUIPMENT

Maintenance of pesticide application equipment includes regular inspection of the spray tank, pump, hoses, line strainers, pressure gauge, fittings, nozzle tips and strainers. Check the sprayer prior to and following extended storage, and before each use. **Always wear personal protective equipment when handling spray equipment.**

Spray tanks: Spray tanks are made of stainless or galvanized steel, fiberglass or plastic, including polyethylene or polypropylene. These materials are fairly non-absorptive, so no pesticide residues should be left in them after being cleaned. However, fiberglass tank linings, if scratched, will absorb pesticides. Cracks and chips in the epoxy coating of galvanized tanks must be repaired with epoxy material; otherwise, the exposed metal may corrode. Periodically check tanks for cracks, rust or corrosion that will weaken the tank and eventually develop into a leak. Make sure the spray tank is securely fastened to the sprayer

Pump and pump seals: The pump and all its components must be in good working condition. Pump seals, 'O' rings or cup washers of leather or synthetic material may dry out and shrink if the sprayer has not been used for an extended period or stored improperly. The solvents in some pesticide formulations can damage pump seals, resulting in leaks around the pump or inefficient pumping.

Hoses: Replace hoses that are cracked or leaking. Hoses used to apply pesticides can never be completely decontaminated. There will always be some pesticide residue left in them. Those that are replaced must be properly disposed of and not reused for any other purpose.

Line strainers and screens: Always use strainers and screens when the equipment is in operation. These filter out debris and foreign particles that can plug nozzles and reduce sprayer performance.

Pressure gauges: Fluid pressure in the spray system is monitored by a pressure gauge. The gauge measures spray pressure through the nozzles when located between the pressure regulator and the spray nozzles. Consequently, a change in pressure can mean a potential malfunction. Make sure pressure gauges are in good working condition and properly calibrated.

Fittings and clamps: Loose or cracked fittings are frequently a source of leaks. Make sure fittings and clamps are snug prior to putting the system under pressure and pumping liquid. Once the system is under pressure, check for leaks.

Nozzle tips and strainers: Check nozzles routinely to make sure they are not plugged. Worn nozzles mean more chemical sprayed and often result in an irregular spray pattern and inconsistent results. Nozzle openings may also change, especially when abrasive formulations, such as wettable powders, are frequently used.

Replace them when wear causes flow to exceed that of a new tip by five to 10 percent.

For example, suppose the nozzle tip manufacturer states that your particular nozzle tips should provide 50 ounces of flow per minute at 30 pounds per square inch (psi). Use an error range of 10 percent (0.10). By using a calculator, simply multiply 50 x 0.10 and add to 50 to find the upper limit; 50 ounces x 0.10 = 5 ounces. Then 5 ounces + 50 ounces = 55 ounces.

Now subtract 5 ounces from 50 ounces to find the lower limit; 50 ounces - 5 ounces = 45 ounces. Any flow at 30 psi that is between 45 and 55 ounces of flow per minute is acceptable. Anything above 55 ounces or below 45 ounces per minute is not acceptable and you may consider changing the nozzle tips.

If nozzle flow is less than expected, clean the nozzles and try again. The nozzles may only be plugged.

APPENDIX L
MAINTENANCE, CLEANING AND STORAGE OF SPRAYERS

PERSONAL PROTECTION IN HERBICIDE HANDLING[2]

PERSONAL PROTECTIVE EQUIPMENT

Herbicide labels indicate the minimum protective equipment required. This may vary by application technique. Cotton, leather, canvas, and other absorbent materials are not chemical resistant, even to dry formulations.

- Always wear at least a long-sleeved shirt, long pants, sturdy shoes or boots, and socks. The more layers of fabric and air between you and the pesticide, the better the protection.
- Contact the manufacturer for recommendations for protective clothing barriers for gloves, suits, and boots.
- A thick layer of spray starch on clothing will add some protection from pesticides.
- Hands and forearms usually receive the most pesticide exposure. Wear chemical-resistant gloves, and tuck shirt sleeves into gloves (gloves should reach up the forearm, with cuffs to catch runs and drips).
- Canvas, cloth, and leather shoes or boots are almost impossible to clean adequately. Wear chemical-resistant rubber boots that come up at least halfway to the knee if the lower legs and feet will be exposed to herbicides or residues.

AVOIDING CONTAMINATION

- Wear chemical-resistant gloves (rubber or plastic such as butyl, nitrile, or polyvinyl chloride are common types).

- Make sure gloves are clean, in good condition, and worn properly. Replace gloves often. Wash and dry hands before putting on gloves. Wash gloves before removing them.
- Wash hands thoroughly before eating, drinking, using tobacco products, or going to the bathroom.
- Cuff gloves if pesticide is expected to run down towards the sleeves. Tuck sleeves into gloves.

EYE AND RESPIRATORY PROTECTION

- PPE labeling might require goggles, face shields, or safety glasses with shields. Some formulas or handling activities pose more risks to eyes than others. Dusts, concentrates, and fine sprays have the highest risk of causing pesticide exposure.
- There are many types of dust-mist masks and respirators, all of which must fit and be used properly to be effective.
- Respiratory protection is most important in enclosed spaces or when the applicator will be exposed to pesticides for a long time.
- Pesticides that can volatilize require the use of respirators. Check label requirements.

PERSONAL CLEAN-UP AFTER HERBICIDE USE

- Wash gloves and footwear (if possible) with detergent and water before removing them.
- Change clothing and put clothes used during application in a plastic box or bag, and keep it away from children or pets Use a mild liquid detergent and warm water to wash your hands, forearms, face, and any other body parts that may have been exposed to pesticides. Take a warm shower and wash your hair and body at the end of the work day.

LAUNDRY

- Do not wash work clothing and personal protective equipment in the same wash water with the family laundry. Handle with care and wash your hands after loading the machine.
- If you have chemical-resistant items, follow the manufacturer's washing instructions. Wash boots and gloves with hot water and liquid detergent. Wash twice, once outside and once inside. Air-dry boots and gloves.
- Rinse clothes in a machine or by hand.
- Wash in plenty of water for dilution and agitation.
- If using a washing machine, using heavy-duty liquid detergent in hot water for the wash cycles.
- After washing the clothes, run the washer through one complete cycle with detergent and hot water, but no clothing, to clean the machine.
- Hang items to dry if possible in plenty of fresh air. Do not hang in living areas.
- Using a clothes dryer is acceptable, but over time the machine may become contaminated with pesticide residues.

---

[2] Adapted from Ohio State University's Extension Publication #825 "Applying Pesticides Correctly" by Jennifer Hillmer, The Nature Conservancy-Ohio

APPENDIX L
MAINTENANCE, CLEANING AND STORAGE OF SPRAYERS

PROCEDURES FOR MIXING, LOADING, DISPOSAL, AND STORAGE OF HERBICIDES

- All mixing of pesticides will occur at least 100 feet from surface waters or wellheads or per label.
- Dilution water will be added to the spray container prior to addition of the herbicides.
- All hoses used to add dilution water to spray containers will be equipped with a device to prevent back siphoning.
- Applicators will mix only those quantities of herbicide that can be reasonably used in a day.
- Prior to mixing, determine the order that chemicals will be added to the mix. Generally, adjuvants are added prior to the herbicide, but consult the label for specific instructions. When mixing, start by filling the spray tank or other mixing vessel half to three-quarters full with water. The water should be clean and clear to prevent contamination of the mixture or clogging of tank nozzles and hoses. The water should have a neutral or slightly acidic pH, as alkaline water can cause the pesticide to breakdown prior to application. Add a buffer or acidifier to the water if necessary (see Appendix K).
- Avoid metal measuring utensils as some pesticides can react with metal. Carefully measure the herbicide concentrate and add it to the tank water.
- Small measuring errors can lead to large errors in the amount of pesticide applied. Be aware of if you are using the active ingredient (a.i.) or acid equivalent (a.e.) of the herbicide (see Appendix L). The measuring container should be rinsed and the rinsate added to the tank solution.
- During mixing, mixers will wear all necessary personal protective equipment as required by the pesticide label and the Health and Safety handbook.
- All empty containers will be tripled rinsed and the solution will be disposed of by spraying near the application site at rates that do not exceed those on the spray site.
- All unused pesticide will be stored in a locked building, with spill containment and meet requirements of a temporary pesticide facility FSH 2109, 40.
- All empty and rinsed herbicide containers will be punctured and properly disposed of. If the herbicide label states that the container may not be disposed of in regular sanitary landfills, call your county or municipal waste department for information on Hazardous Material Collection dates.
- After use, first clean and store application equipment and then thoroughly rinse personal protection gear (gloves, boots, etc.) with cold water from a hose or container that is hand-held (gloves off) and was not used during application work. All personal protection gear should then be washed in mild soap and water. Finally, applicators should wash their hands and any herbicide-exposed areas of their bodies. Applicators should shower and change clothing as soon as possible. Clothes used during the application must be washed and dried separately from other clothing before it is worn again, even if it appears uncontaminated.

EMERGENCY PRECAUTIONS AND EQUIPMENT

Applicators must have easy access to emergency decontamination and first aid kits whenever they are applying herbicides, even if they are out in the field. All applicators should have access to an eyewash kit and at least 2 gallons of clean water. Decontamination kits are available from many suppliers or can be assembled independently. Rubber buckets or tubs with tight sealing lids are convenient for homemade kits and should include:

- Two (or more) 1 gallon containers filled with potable water,
- Eyewash kits or eyewash bottles with buffered isotonic eyewash,
- Hand or body soap (bring enough for all workers to thoroughly wash their hands when in the field),
- Paper or other disposable towels,
- A full tyvek coverall with foot covers,
- A map and directions to the nearest medical facilities.

POSTING TREATED AREAS

Federal requirements for posting treated areas, if any, are listed on the herbicide label. Always keep treated areas off limits to the public at least until the herbicide dries. Treated areas may be kept off limits for longer periods if the herbicide is persistent in the environment. When posting areas that are accessible to the public (trails, trailheads, camping areas, etc.), place notices at the usual points of entry or along the perimeter of treated sites. The posting should include a notice that the area has or will be treated, the name of the herbicide used, the date of the treatment, appropriate precautions to be taken, the date when re-entry is judged to be safe, and a phone number for additional information. The notices should be removed after it is judged safe to re-enter the area.

AERIAL SAFETY

Aerial applications require an additional air safety plan, FHS 6709.11 (22.11b), 2109-14. Also see Protection Measures outlined in Appendix C and Aerial Treatment Guidelines in Appendix N.

HERBICIDE SPILL PLAN

Pesticide spill prevention and clean-up, as well as storage, transport, and disposal procedures are covered in detail in *Forest Service Handbook (FSH) 2109.12 Pesticide Storage, Transportation, Spills, and Disposal.* Any herbicide projects would follow the direction given in this handbook. It is available for review at U.S. Forest Service offices.

A "Pesticide Spill Kit" for emergency spills should be available during operations (see the following Pesticide Spill Kit equipment list).

PESTICIDE SPILL KIT

The following equipment will be available with vehicles or pack animals used to transport pesticides and in the immediate vicinity of all spray operations.

- Emergency phone numbers
- Labels and MSDSs of all pesticides on hand
- Copy of the Spill Plan
- Personal Protective Equipment: rubber gloves, footwear, apron, goggles, face shield, respirator
- Heavy plastic bags for material storage
- 10 lbs. of absorbent materials (cat litter, vermiculite, paper, etc.) or the equivalent in absorbent pillows
- Shovel, broom, dustpan
- Heavy duty detergent, chlorine bleach, and water
- Sturdy plastic container that closes tightly and will hold the largest quantity of pesticide on hand
- First aid supplies
- Fresh water (at least 3 gallons; bring extra for wash-up after application)
- Soap (dish soap or hand soap)
- Towels
- Change of clothes
- Additional items required by labeling

Material Safety Data Sheets will be reviewed with all personnel involved in the handling of pesticides.

CLEAN UP OF PESTICIDE SPILLS

Minor Spills (less than 5 Gallons): Keep people away from spilled chemicals. Rope off the area and flag it to warn people. Do not leave unless someone is there to confine the spill and warn of the danger. If the pesticide was spilled on anyone, wash it off immediately.

Confine the spill. If it starts to spread, dike it up with sand and soil. Use absorbent material such as cat litter, absorbent pillows, soil, sawdust, or absorbent clay to soak up the spill. Shovel all contaminated material into a leak proof container for disposal. Dispose of it, as you would excess pesticides. Do not hose down the area, because this spreads the chemical. Always work carefully and do not hurry. Control access to the area until the spill is completely cleaned up. Notify the District Ranger and District Pesticide Coordinator of the minor spill.

Major Spills (Greater than 5 Gallons): The cleanup of a major spill may be too difficult for you to handle, or you may not be sure of what to do. In either case, keep people away, give first aid if needed, and confine the spill. Then call Chemtrec or the State pesticide authorities for assistance. Chemtrec stands for Chemical Transportation Emergency Center, a public service of the Manufacturing Chemicals Association with offices located in Washington D.C. Chemtrec provides immediate advice for those at the scene of emergencies. Chemtrec operates 24 hours a day, seven days a week, to receive calls for emergency assistance. For help in chemical emergencies involving spills, leaks, fire, or explosions, call toll-free **800-424-9300** day or night. This number is for **emergencies** only. Another number that is useful is EPA's National Response Center for Toxic Chemical and Oil Spills - 1-800-424-8802. Notify the District Ranger, District Pesticide Coordinator, and the Forest Pesticide Coordinator of any major spill.

If a major pesticide spill occurs on a highway, have someone call the highway patrol or the sheriff for help. (Carry these phone numbers with you.) Do not leave until responsible help arrives.

Decontamination: The small amount of herbicide remaining after the cleanup process on the road surface, storage area floor, or nonporous truck bed, must be decontaminated or neutralized. The decontaminating or neutralizing agent used will vary according to the nature of the spilled chemical. Soil, roadways, floors, and nonporous surfaces should be decontaminated in the following manner:

Soil. Contaminated soil should be removed to a depth of at least 2 inches below the contaminated zone and placed in drums for disposal.

Roadways, Floors, and other Nonporous Surfaces. Reference the herbicide's MSDS for spill decontamination. Most herbicides used for weed control outlined in the current environment impact statement should not be treated with a specific chemical decontaminant.

For those pesticides that require a decontaminant, spread the appropriate decontamination material on the spill and work it into the surface using a coarse broom. Allow the decontaminant to sit for two hours.

NORTHERN REGION GUIDANCE

In addition the section from the Northern Region Emergency and Disaster Plan entitled *"Hazardous Materials Releases and Oil Spills"* will be reviewed with all appropriate personnel (see following pages). Notification and reporting requirements as outlined in this section will be followed in the unlikely event of a serious spill.

Hazardous Materials Releases and Oil Spills
(Excerpted from the Northern Region Emergency and Disaster Plan)

Definition: A hazardous materials emergency or oil spill is defined as any release or threat of release of a hazardous substance or petroleum product that presents an imminent and substantial risk of injury to health or the environment.

A release is defined as any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injection, escaping, leaching, dumping or disposing into the environment.

Releases that do no constitute an immediate threat, occur entirely within the work place, are federally permitted, or are a routine pesticide application, are not considered to be an emergency and are not covered by this direction.

Responsibility: The first person who knows of a release and is capable of appreciating the significance of that release has the responsibility to report that release.

Only emergency release response and reporting is covered by this direction. Appropriated Regional Office staff specialists who should be notified directly of all non-emergency releases will accomplish who should be notified directly of all non-emergency releases will accomplish non-emergency reporting.

An emergency release of a hazardous substance or petroleum product may be from a Forest Service operation or facility; from an operation on National Forest land by a permit holder, contractor, or other third party; or from a transportation related vehicle, boat, pipeline, aircraft, etc., crossing over, on or under Forest Lands. Response and/or reporting by Forest Service employees will differ in each situation:

1. If the release is from a Forest Service facility or operation, the Forest Service and employee(s) is clearly the "person in charge", and is fully responsible for all reporting. Immediate response action is limited to that outlined in emergency plans and only to the extent that personal safety is not threatened.
2. If the release is from a third party operation, the Forest Service will only respond and/or report the emergency if the third party fails to take appropriate action.
3. If the release is from a transportation related incident, the Forest Service will only respond and/or report the emergency if the driver or other responsible party is unable or fails to take appropriate action.

Response Action Guide: the primary responsibility of any Forest Service employee(s) encountering a hazardous materials emergency or oil spill is completed and accurate reporting to appropriate authorities in a timely manner.

Forest Service employee(s) will not assume an incident command role for any hazardous materials emergency of spill, but may provide support services as directed by an authorized Federal On-Scene Coordinator (OSC) or other State or local authority.

Within the limits of personal safety, common sense, and recognition of the dangers associated with any hazardous materials emergency or spill, Forest Service employee(s) may provide necessary and immediate response action until an authorized OSC or other authority can take charge. These actions may include:

- Public warning and crowd control;
- Retrieval of appropriate information for reporting purposes.

Additionally, and only after verification of the type of hazardous material involved and its associated hazards, a Forest Service employee(s) may also take actions including;

- Rescue of persons in imminent danger;
- Limited action to mitigate the consequences of the emergency.

Under no condition shall a Forest Service employee(s);

- Place themselves or others in imminent danger.
- Perform or direct actions that will incur liability for the Forest Service.

If there is any question that the emergency may constitute a threat to personal safety, limit your response to public warning and reporting or the incident.

Precautions: When approaching the scene of an accident involving cargo, or other unknown or suspected hazardous material emergency including oil spills:

- Approach incident from an upwind direction, if possible;
- Move and keep people away from the incident scene;
- Do not walk into or touch any spilled material;
- Avoid inhaling fumes, smoke, and vapors even is no hazardous materials are involved;
- Do not assume that gases or vapors are harmless because of lack of smell; and,
- Do no smoke, and remove all ignition sources.

ORANIZATIONS FOR EMERGENCY AND TECHNICAL ASSISTANCE

- CHEMTREC – Chemical Transportation Emergency Center – 800-262-8200 (24 hours) (For assistance in any transportation emergency involving chemicals).
- Rocky Mountain Poison Control Center – 800-222-1222 (24 hours)
- National Agricultural Chemicals Association – 513-961-4300 (for pesticide technical assistance and information referral).
- Bureau of Explosives -905-953-8991 (For explosive technical assistance).
- Centers for Disease Control - 800-232-4636 (For technical assistance regarding etiologic agents).
- EPA Region 8 (MT, ND, SD) Emergency Response Branch 303-312-6385
- Montana Department of Health and Environmental Sciences (24 hours) 406-444-6911
- Montana Water Quality Bureau 406-444-6697
- South Dakota Water Quality Bureau 605-773-3754
- Montana Solid Waste Management Bureau 406-444-2821
- South Dakota Solid Waste Management Bureau: (605) 773-3153

TABLE M - 1. HAZARDOUS MATERIALS SPILLS CONTACT LIST AND IMMEDIATE ACTION GUIDE

RESPONSIBILITY	ACTION	CONTACT
Individual	• Do not expose yourself or others to any unknown materials. • Do not attempt rescue or mitigate until material has been identified, and hazards and precautions noted. Warn others and keep people away. Approach only from upwind. Do not walk in or touch material. Avoid inhaling fumes and vapors. Do not smoke and remove ignition sources. • Report the incident. Complete "Reporting Action Guide" within reasonable limits of exposure and timeliness, and report information to District/Forest Pesticide Coordinator • If there is any question that the incident is a threat to personal safety, limit response to public warnings and reporting.	District Ranger and District/Forest Pesticide Coordinator
District Pesticide Coordinator	• Insure reporting individual is aware of hazards associated with incident. • Obtain as much information as possible, complete a copy of the Reporting Action Guide and relay all information to the Forest Pesticide Coordinator. • For fixed facilities, verify if possible, whether or not an emergency guide, Spill Prevention Control and Countermeasure Plan, or similar response plan is available for the specific emergency. If so, implement the response actions as indicated. • Dispatch additional help, communication systems, etc., to incident scene if incident is on National Forest land or is caused by Forest Service activity or facility. Otherwise support as requested by official in charge. • If there is any question that the incident is a threat to personal safety, limit response to public warning and reporting. • Immediately contact the Forest Pesticide Coordinator.	Forest Pesticide Coordinator

APPENDIX M
HERBICIDE SAFETY:
PERSONAL PROTECTION, HANDLING, SPILLS, JHAs

RESPONSIBILITY	ACTION	CONTACT
Forest	• Forest Pesticide Coordinator who will take the following actions: Determine if the incident is a true emergency. • Determine who the responsible party for the incident is, and whether appropriate actions and reporting have been accomplished. • From available information, determine hazards and precautions, if possible, and relay further instructions to reporting individual through the District. • Initiate appropriate local reporting actions, and coordinate responses with District. • Arrange Forest support for on-scene coordinator and/or local emergency response officials as requested. • Make appropriate local emergency contacts as directed by Forest Hazardous Materials Incident Coordinator. • Relay information from Forest Hazardous Materials Incident Coordinator back to District and up to Regional Office as appropriate. • Immediately contact the Regional Hazardous Materials Incident Coordinator.	Forest Pesticide Coordinator will determine extent of emergency. If incident is determined reportable, contact: National Response Center; EPA Hazmat emergency response; Regional Hazardous Materials Coordinator; County sheriff and/or county disaster and emergency services coordinator; State Emergency and Disaster organizations; and Internal Forest Contacts
Regional Incident Hazardous Materials Incident Coordinator	• The Regional Hazardous Materials Incident Coordinator who will take the following actions: • Personally work with Forest Hazardous Materials Incident Coordinator to determine extent of the emergency. If incident is reportable, implement the following actions: By computer mailing list notify the Regional Forester, Deputy Regional Forester, Staff Directors and Attorney-in-charge (OGC); Contact other Regional Office (RO) specialists, other agency personnel, etc., as necessary to determine scope of problem and appropriate actions. RO specialist contacts include: Regional Watershed Coordinator (water); Regional Reclamation Officer (mining); Regional Safety and Health Program Manager; Regional Cooperative Forestry and Pest Management; Arrange Regional Support for on-scene coordinator and/or local emergency response officials as requested; Arrange a Regional Investigation/follow-up team if determined necessary; Keep Regional Forester, Staff Directors and OGC advised of situation via routine computer updates.	Regional Hazardous Materials Incident Coordinator; Regional Emergency Coordinator; If incident is determined to be reportable, verify the National Response Center and appropriate Federal, State, and local contacts have been made; WO Engineering; WO Personnel Management.

Although reporting requirements vary depending on the type of incident, the responsibility of the employee(s) in the field is limited to collecting appropriate information and relaying it to the proper level of the organization in a timely manner. Following is a list of the information that should be collected, if possible; however, it is more important to maintain personal safety and report in a timely manner than to collect all information.

1. Date
    - Time of release/spill:
    - Time discovered:
    - Time reported:
    - Duration of release/spill:
2. Location (include state, county, route, milepost, etc.)
3. Chemical name:
    - Chemical identification number:
4. Known health risks:
5. Appropriate precautions if known:
6. Source and cause of release:
7. Estimate of quantity release (gallons):
    - Quantity reaching water (gallons):
    - Name of affected watercourse:
8. Number and type of injuries:
9. Potential future threat to health or environment:
10. Your Name:
    - Phone number for duration of emergency
    - Permanent phone number
11. For transportation related incidents, also report:
    - Name and address of carrier:
    - Railcar or truck number:

If there is any doubt whether an incident is a true emergency or whether reportable quantities of hazardous materials or petroleum products are involved, or whether a responsible party has already reported the incident, always report the incident.

APPENDIX M
HERBICIDE SAFETY:
PERSONAL PROTECTION, HANDLING, SPILLS, JHAs

EXAMPLE JOB HAZARD ANALYSIS

FS-6700-7 (11/99)

U.S. Department of Agriculture Forest Service	1. WORK PROJECT/ACTIVITY Weed Spraying with Herbicides	2. LOCATION	3. UNIT
JOB HAZARD ANALYSIS (JHA)	4. NAME OF ANALYST	5. JOB TITLE	6. DATE PREPARED

7. TASKS/PROCEDURES	8. HAZARDS	9. ABATEMENT ACTIONS Engineering Controls * Substitution * Administrative Controls * PPE
General herbicide use	Exposure/Contamination	Read the product label before each use and follow the directions
Loading	Spill/contamination Back/muscle strains	Keep chemicals and related equipment in designated area of vehicle outside the passenger area. If bedliners are used, only use those made of non-porous material. Carry herbicide containers inside a catch basin. Make sure lids are on tight, containers upright & secure; use gloves when handling chemical containers. Read the Material Safety Data Sheets for herbicide used. Carry emergency containment equipment (shovel, kitty litter, plastic bags). If less than 5 gallons, then disperse widely. If more than 5 gallons, this is considered a hazardous material spill; notify dispatch and they will notify other officials. Use good lifting techniques: bent knees, close postioning, upright back.
Mixing herbicides	Exposure/spills Synergism	Wear face shield or goggles, chemical resistant rubber gloves, long sleeves, pants, and chemical resistant rubber boots (use insoles to improve fit). Fill tank half way with water, add herbicide, then finish filling tank. Read Material Safety Data Sheets for spcific herbicides. Use only recommended amounts. Close container immediately after use. Be Aware of the effects of Mixing chemicals. Read labels.
Spraying herbicides	Exposure Trips/Falls	Wear personal protective equipment: goggles or glasses to protect eyes from drift; long sleeves; clean chemical resistant gloves to protect arms and hands; long pants and chemical resistant boots. Use unlined equipment because liners can carry residue. Wear disposable or washable coveralls as added protection against drift or spills. Wash or dispose of after each use. Avoid walking through treated areas. Think about hands: do not touch your face or food until hands are washed. Treat chemicals with respect. Don't get complacent. Do not spray if temperature is over 85 degrees Fahrenheit because of increased volitilization. Do not spray if winds are above about 10 miles per hour. Take extra time when walking with PPE on. Goggles and respirators can reduce your field of vision. Watch your footing and balance. A backpack sprayer can throw you off balance. Use insoles in rubber boots to improve fit.
Clean-up	Contamination	After emptying sprayer tank fill with water and spray as if it were a herbicide to clean the equipment. Wash outside of sprayer with soap and water in the field. Wash all personal protective equipment in the field with soap, disperse solution on site. Return all equipment to proper storage area. Bathe or shower as soon as possible after spraying. Wash clothing separate from other laundry.
Transporting to and from worksite	Vehicle accidents Chemical spills	Drive defensively, ensure vehicle is in proper running condition, use safety belts. Secure chemicals, backpack sprayers & slip-tank. Carry shovel and plastic bags to clean-up spills. If less than 5 gallons, then disperse widely. Otherwise, if more than 5 gallons, this is considered a hazardous material spill; notify dispatch and they will notify other officials.
Spraying herbicide - slip-tank sprayer	Personal contamination	Check fittings and hose clamps for leaks before use; keep spray gun pointed in safe direction, store securely & relieve excess pressure when not in use. Wear all PPE: gloves, boots, safety glasses, coveralls.
Spraying herbicide - backpack..	Personal contamination Slips/Falls	Keep wand pointed down at all times; wedge hand between handle and trigger when traversing rough terrain; check equipment for leaks before use; don't carry heavy loads in sprayer; wear all PPE. Working on rough terrain - look for firm footing; avoid area if too steep, tighten shoulder straps to prevent excessive tank movement.
Spraying herbicide - ATV	Vehicle accidents Personal contamination	Travel at speeds less than 15 mph, and on slopes less than 10 %, the following PPE requirements are less stringent than for other uses of ATVs because of low speeds: wear an approved mountain bike helmet that protects your head but not cause overheating; wear rubber gloves and boots when spraying herbicides (avoid leather that absorbs chemicals); wear eye protection, long sleeved shirts and pants. When loading and unloading ATVs from trailers or pickup trucks use caution, beware of pinch points, keep ramps at low angle by using natural terrain features such as slope/ditches, watch for hidden obstacles when backing; make sure ATV is securely fastened when transporting (fasten to chassis to avoid influence of shock absorbers). If spray tank is loaded with liquid, the extra weight will change the ATVs center-of-gravity; never climb steep ramps or slopes. Inspect sprayer equipment prior to use, inspect fittings hoses and nozzles, replace if worn. Keep wand pointed down and be aware of wind direction when traveling.
ATV travel between project areas	Vehicle accidents	When traveling at speeds greater than 15 mph, or on slopes less than 10%, wear a motorcycle helmet (three quarter or full) The helmet shall meet requirements of the Department of Transportation, ANSI or Snell Memorial Foundation standards. Also wear leather gloves, long pants and long sleeved shirt, appropriate foot wear, eye protection (such as goggles, glasses or face shield). Review sections 13.22 – to 13.24 in FSH 6709.11 Health and Safety Code Handbook.

10. LINE OFFICER SIGNATURE	11. TITLE	12. DATE

- End of Appendix M

APPENDIX N
AERIAL SPRAY GUIDELINES AND DRIFT MODEL RESULTS

AERIAL SPRAY GUIDELINES[1]

The following guidelines were taken from Aerial Herbicide Application for Noxious Weed Control in Northern Region (Kulla, A. 2003), Appendix F of the Lolo National Forest Big Game Winter Range and Burned Area Weed Management Final EIS (USFS. 2001b) and Appendix G of the Gallatin National Forest Noxious and Invasive Weed Control EIS. These guidelines are intended as a practical field guide for weed managers who may be considering use of aerial herbicide application as part of an integrated pest management program. Some of the terminology and work force, fiscal year, planning references are specific to Forest Service project planning. The information and observations in this guide are specific to large droplet liquid herbicide applications and does not address pellet, insecticide or other fine droplet aerial application projects.

Why Aerial Spray?

Scale: The impacts of weeds on native vegetation, wildlife, soils, fisheries, aesthetics, wilderness and a host of other resources are widely recognized by both the public and land managers. At the same time, the invasive plant problem in the northern Rockies has grown beyond the scale of ground based weed control.

While ground based and biological weed management practices still are important elements in an IWM program, they have site and species limitations. Ground based application methods such as truck, ATV, horseback, backpack or atomizer applications are generally most effective on:

- New or small infestations or
- Infestations on flat and/or open ground and
- Near a road or trail

Biological control alone, while effective and applicable in certain situations, is:

- Often cyclic,
- Not available for many weed species,
- Not as effective on weed infestations with several weed species and
- Not effective for small or pioneering infestations scattered over a large landscape.
- Not effective on complex terrain with a wide range of slope, aspect, soil and canopy combinations.

Aerial application is an efficient and useful method land mangers can add to their IWM toolboxes for weed infestations involving:

- Multiple weed species,
- At landscape scale, and
- On steep and remote areas

Cost: Aerial application reduces costs in at least two ways. Helicopter aerial application in the Northern Region costs around $10 to $15 / acre. Ground based applications can range from $25 / acre for truck based broadcast spraying to as high as $300 or more / acre for backpack applications. The lower application cost combined with the growing scale of the problem puts aerial application in a useful position when we consider that weed infestations are growing faster than any anticipated increases in weed budgets.

Access: Many wildland infestations are occurring in remote and/or very steep topography. Aerial application can quickly (in terms of application time), safely (in regards to applicator and public exposure) and efficiently (in terms of infested area coverage) treat infestations far from roads and trails and in steep or otherwise undrivable terrain.

Safety / Exposure: Aerial application improves safety and reduces worker and public exposure to herbicides.

Worker exposure and risk are influenced by the:

- Time a worker is exposed to a product,
- Physical proximity and exposure to a product,
- Personal protective equipment and safe handling practices,
- Toxicity of the product,
- Terrain, hazards, and weather in the treatment area.

Aerial application reduces application time and the time a worker is exposed to a product. It also reduces the number of applicators needed to accomplish a project and the chance of slips, falls and spills associated with ground based treatments in steep, remote or hazardous terrain.

---

[1] Aerial applications require an additional air safety plan, FHS 6709.11 (22.11b), 2109-14.

Public impacts are influenced by:

- The time it takes to treat an area and the resulting limitations on public use / access,
- Individual physical or philosophical sensitivity to a product, and
- Toxicity of the product.

Aerial application reduces the time that a treatment area is unavailable to the public. It also provides an aerial platform from which an applicator can see people who may have unknowingly entered a treatment area.

Weather and wind patterns also affect worker and public exposure. Aerial application reduces the potential for both worker and public exposure from weather related factors because you can accomplish more acres in less time and thereby capitalize on favorable weather conditions. Worker and public exposure are reduced when it takes less time to treat a larger area.

Efficacy: Aerial application allows a manager to quickly complete projects when the target weed(s) is at the most susceptible phenological stage and weather conditions are most favorable for efficacy. This maximization of efficacy factors can reduce the number and scale of follow up treatments.

Overgrazing and Grazing Animal Distribution: Lower application costs allow for more ecologically compatible weed management. With lower application costs, a manager can afford to treat a larger project area at once. Higher treatment costs may necessitate treatment of only a portion of a project area each year. This can inadvertently attract big game or livestock to the treated area and result in overgrazing. Overgrazing in turn can reduce the retreatment interval. By treating larger areas at one time, big game and livestock will be better distributed over a larger area as they express preference for the improved forage resulting from the treatment.

Reduced Wildlife Disturbance: The short operational time needed for aerial treatment minimizes wildlife disturbance and use of an area. Aerial applications may typically take only one operational day compared to a week to a month for ground-based treatments.

Visual Quality: Lower application costs that allow treatment of larger areas with a single entry reduce the visual impacts that result from annual treatment of only a portion of the project area. The color and texture of a landscape scale treatment is homogeneous rather than broken up by color, texture and straight lines.

Relation with Fire

The conditions that result from prescribed fire and wildfires are conditions that favor weeds. Open canopies, more direct sunlight to the ground, reduction of other competitive vegetation, soil damage from high heat, soil disturbance from fireline construction, and the potential introduction of weed seed from firefighters and firefighting equipment all favor the establishment of new weed species and the spread of weeds already found in an area.

Species-specific research to describe quantitative effects of fire on five weed species (spotted knapweed, sulfur cinquefoil, leafy spurge, Dalmatian toadflax and St. Johnswort) is being conducted on the Lolo NF in cooperation with the National Bison Range and the City of Missoula. Research is also underway to determine whether managers should burn and spray or spray and burn.

Aerial Spray Control Strategies

Weed management objective: Weed managers should develop realistic and obtainable weed management objectives before beginning a direct weed control program. Even selective herbicides will affect non-target forbs. The *effect of invasive weeds* on native or desirable vegetation needs to be recognized and considered in relation to the *effect of herbicides* on non-target vegetation. Aerial application is a general treatment and it can be difficult to avoid small or isolated non-target vegetation. Non-target vegetation can be flagged and smaller sites can be tarped to avoid treatment, but the effect of weed control on *individual* non-target plant species should be carefully weighed in relation to the effect of unchecked weed spread on the *overall population viability* of non-target species both on and off the treatment site.

The herbicides and rates used for weed control in the Northern Region are selective (depending on rate) and many do not generally kill woody vegetation or grasses. While woody vegetation may show short-term effects, widespread mortality or damage is uncommon. Forbs are the non-target plants most at risk from the use of wildland weed herbicides. Whether native forb impacts are long term or short term depends on the rate and frequency of treatment, which is influenced by size of the infestation and whether you have rhizomatous or non-rhizomatous weeds.

While an objective to *"Restore native plant communities"* may be desirable, it may be unrealistic or unobtainable on widespread or rhizomatous weed infestations. More realistic and obtainable objectives may include:

- Improving or protect existing or adjacent native plant communities,

- Improving wildlife forage areas,
- Preventing new weed species from establishing in an area,
- Containing or reducing the acreage of difficult to control weeds (such as rhizomatous species) and/or
- Controlling areas of weeds growing in large difficult terrain to access by ground.
- Controlling widespread weeds on areas with high resource value (such as concentrated public recreation areas, big game winter ranges, or adjacent to neighboring landowners with active weed control programs).

Spring vs. Fall Treatments

Both spring and fall treatments have advantages and disadvantages. Fall treatments have less effect on non-target forbs. Climatologically, the weather is more consistent in the fall, but may be consistently too cold, especially in the morning. A drawback is that there is greater annual variability in the fall treatment window. It is difficult to know (and plan) when the fall treatment window will arrive. On some years there may be no fall treatment window due to warm weather and no rainfall. If it does arrive, it may last only a week or as long as several weeks. The end of the fall window can arrive abruptly with the snowfall and cold windy weather.

The spring treatment window is relatively long and dependable in terms of start and end date and falls at a time when you know and can plan for budget and staff. The days are longer in the spring, which allows more application time (and acres) each day. Late sunset gives application operations the option of shutting down midday if the wind comes up and resuming in the evening when the wind dies down.

Both seasons can conflict with aircraft availability as a result of prescribed burning or wildfires.

Re-treatment Considerations

Before beginning an aerial treatment program, re-treatment needs, funding and scheduling should be considered. Keep in mind that the objective is not to simply kill the existing standing weed crop, but to:

- Restore and/or encourage desirable and competitive vegetation and
- Deplete the weed seed soil bank.

With these objectives in mind, a single treatment may be insufficient. As with all weed control methods, initial herbicide treatments should include planning for follow up treatments. Follow up treatment frequency should be influenced by the soil seed life of the most abundant and longest-lived weed on the site and the residual control provided by the herbicide selected. Spotted knapweed for example, has a soil seed life of about eight to 10 years. Once a treatment program begins, managers should plan for follow up treatments based on the soil seed life of the weeds present and the residual control of the herbicide selected.

For example, if spotted knapweed is being treated with picloram, a manager may consider follow up treatments every three growing seasons (the approximately residual control period for picloram) for three to four cycles (3 growing seasons x 3 to 4 cycles = 9 to 12 years – the approximately soil seed life for knapweed). Commitment to this program is important because if a cycle is missed and a weed seed crop is allowed to develop, the treatment cycle may have to be extended.

Pre-field Project Preparation

It is helpful to develop a checklist of the protection measures (Appendix C) and management requirements. This checklist should clearly identify tasks and provide a place to date and sign off as each task is completed. This checklist should be filed in the project file.

Some of the items that can go on the checklist include:

- Herbicide prescription, including site specific water quality risk assessment will need to be conducted (see Protection measures, Appendix C). Once the exact treatment areas are delineated in preparation for the contract, treatment acres can be determined for 6th hydrologic unit code (HUC) watersheds potentially affected by aerial application. These delineated areas can be incorporated into the risk assessment to estimate probable herbicide concentrations and allowable treatment acres. If concentrations exceed the recommended safe threshold, treatment acres would need to be reduced to the allowable amount.
- Pesticide Use Proposal
- Protection Measures from NEPA decision.
- Notification of neighbors (Note: neighboring landowners may want to treat their lands when they learn a project is scheduled next to them)
- Pretreatment monitoring plots (these plots should be established during the growing season prior to the treatment)
- Designation of Aerial Equipment Manager (helicopter manager)

- Recon and selection of a helibase (close to treatment area, good road access, away from waterways, reviewed and OK'd by pilot)
- Posting of the area to be treated
- Establish temporary closure orders, when needed.
- Identification and marking of sensitive areas to be avoided
- TES plant and animal considerations

Field Project Layout

It is difficult to pre-determine the treatment day due to weed phenology, weather, and aircraft availability. It is recommended that aerial spray projects be prepped well in advance (2 to 4 weeks) of the anticipated treatment date.

Ground Truthing: Treatment units should be carefully ground truthed prior to treatment to determine:

- Weed species and distribution
- Road system and any differences in roadside infestations in relation to off road infestations
- Herbicide prescription considering both weeds and native vegetation
- Live water, wet areas or other sensitive resources you want to avoid
- Overstory canopy closure

This information can be recorded on aerial photographs that include project boundaries and other adjacent or in holding ownerships. Two copies of these aerial photos should be made, one copy for the project manager and one set for the application pilot to have on board the aircraft. When possible, geo-reference the aerial photo information in order to be able to give the pilot GPS location information.

Buffers and No Treatment Areas: Buffer and no treatment areas should be established around any sensitive resource you want to avoid. These areas may include live water, wet areas, other land ownerships, TES plants or occupied areasAerial treatment buffer zones may vary depending on site characteristics. Treatments may also be designed to avoid any aerial treatment near sensitive resources (see Appendix C). . The width of an aerial treatment buffer zone near sensitive resources should consider:

- Slope (steeper = wider)
- Vegetation (less overstory vegetation = wider)
- Wind prescription (applications should be made only with low upslope winds)
- Overstory vegetation (which determines release height - higher release height = wider buffer)
- Use of a drift agent (no drift agent = wider buffer- drift reduction agents are recommended near buffer areas)
- Droplet size (smaller droplet size = wider buffer)
- Topographic position (narrow deep draws = wider buffer areas)
- Sensitivity of neighboring landowners (more sensitive = wider buffer)

Buffer Monitoring: Water sensitive "drift cards" can be placed as needed within the buffer zones to document herbicide placement. The number of drift card lines should be determined by the sensitivity of the resource and the size of the area. The number of card lines should be considered carefully because they are time intensive and require additional project staff. Cards should:

- Be placed equidistance within the buffer from the sensitive resource to the beginning of the treatment area.
- Have the Line # and location on the line recorded on each card at the time of placement.
- Be placed 10 feet to 10 yards apart depending on the width of the buffer area.
- Be placed on drift cardholders.
- Be placed immediately before application and picked up and stored in waterproof bags immediately after treatment.
- Not be placed the day or evening before early morning applications due to dew, fog or humidity contamination.
- Be laid out in a dry office setting in the order they were placed and interpreted as soon as practical. (Cards often come with interpretation information and sampling square templates.)
- Filed in waterproof bags in the project file.

It is critical that those placing drift cards be briefed on handling, placement, contamination, collection and storage of the cards. Those placing and picking up the cards should carefully check the card condition as they are placed and picked up and note any non-herbicide contamination. Contamination can include fog, high humidity, dew droplets off leaves, moisture on your hands, improper card handling, rodent urine or foot prints, wildlife or insect moisture and/or feeding on the cards.

If drift cards are used, card lines should also be placed in treatment areas under full spray conditions to serve as a reference for determining percentage of full spray on cards in buffer areas that have detection. The purpose of buffers

is to protect the resource that is at the end of the buffer area, so detection within the buffer areas may be acceptable as long as the sensitive area itself is protected.

In-stream water sampling has limitations in that it is expensive, should be sterile and automated to avoid contamination, only indicates whether herbicide reached a water way in detectable quantities, does not indicate how close herbicide may have come to the sensitive resource and is subject to dilution depending on stream volume and velocity.

Drift Mitigation Measures: Drift mitigation measures may include:

- Use of a drift agent
- Use of buffer areas next to sensitive resources
- On site weather monitoring
- Treatment next to sensitive areas when wind is upslope and gentle
- No treatment during inversions
- No treatment when winds in the project area are > 6 mph
- No treatment when weather forecasts predict rain in next 24 hours

Unit Marking Strategies: In agricultural or residential settings treatment area boundaries are clearly defined by fences, roads and / or buildings. Wildland project managers should identify treatment areas on the ground and be sure the application pilots know where treatment and no treatment areas are.

Wildland unit marking strategies fall into two general categories:

- Identification of specific treatment polygons and delineation of where *to treat* within a larger project area, or
- Identification of the general project area and delineation of areas *not to treat*.

Large wildland treatment areas that include many polygons and a mix of timbered and open areas may be difficult to mark and find from the air. If treatment units are large and there are only three to five in the project area it may be practical to mark each individual unit. If there are many units in a large area, it may be more efficient to mark the project area boundary and buffers and instruct the pilot *which areas not to treat* within the larger project area. The no treatment areas could include marked buffer areas (which would include waterways and wet areas), talus, rock and cliffs and areas with a closed overstory canopy.

On the Ground Unit Marking: Technology is rapidly developing that allows managers to mark treatment units digitally. On the ground block marking is the most expensive part of project layout and through the use of digital marking may be eventually eliminated. Some on the ground features and topography may require some degree of on the ground marking.

When on the ground marking is needed, uniform unit marking is recommended to ensure consistency between treatment blocks, different ranger districts and to reduce pilot workload. Unit marking can be done with high contrast, high strength flagging staked or rocked to the ground or with aerosol survey paint. Markings should be kept as simple as possible. Frequency of marking should depend on the specific site and site features. Some suggested unit markings are:

- Treatment unit boundary: The vertical line should be on the unit boundary with the perpendicular line pointing into the treatment unit. These markings can also be places were roads enter and leave the treatment units. A unit number can be added for further aerial orientation.
- A horizontal line to mark the edge of a buffer or area to be avoided. The line should be parallel to the feature inside the buffer area.

All ground marking schemes should be closely coordinated with the application pilot.

Digital Unit and Treatment Marking: GPS guided navigational devices are available that allow an aircraft to develop a digital treatment polygon file from either a recon flight or an on the ground unit layout. These digital shapes appear on a navigational screen in the aircraft and are used to guide the pilot to the units. GPS line files are collected for each spray swath and are displayed on the polygon on the screen during application. These swath lines can be printed after application to provide a digital map record of the treated area. The swath width can be loaded into the program to generate area treated based on swath length and width.

The aircraft recently used on the Lolo NF had the AgNav system. Additional information on this technology is available in *Demonstration of Aerial Spray Aircraft Navigation Systems in Deep Mountain Valleys*, A November 2001 "Tech Tip" by Dick Karsky at the Missoula Technology and Development Center (406.329.3921 or dkarsky@fs.fed.us)

Pretreatment Recon Flight: On or before treatment day, the pilot and project manager should fly the project area with aerial photos in hand to review and discuss treatment area, boundaries, other ownerships, buffer zones and on the ground marking. It is helpful for the project manager to GPS key project locations (such as unit corners or sensitive

areas) prior to the flight to allow the pilot and project manager to quickly and efficiently orient from within the aircraft. Things can look different from an aircraft than from the ground and this step can save flight time.

Equipment

Helicopter and fixed wing aircraft are available for aerial application work. Helicopters have been better suited to the steep topography and diverse vegetation. In 2002 the Lolo NF used a Bell 206 BIII, which carried 70 to 80 gallons of water and herbicide mix. Herbicide was applied in 2 gallons of water / acre. Each 70 to 80 gallon cycle treated 35 to 40 acres. Cycle times were about 15 to 30 minutes depending on the size of the treatment polygon and distance from the helibase. This equated to about 400 to 700 acres of treatment per day.

Aerial applicators typically come with a mix truck equipped with aviation fuel tanks, water tanks, a mix tank and a mix master. Water can be supplied by the Forest Service or by the applicator. Applicator mix trucks are not typically suited to travel over rough or steep forest roads so it is recommended to select a mix site / helibase with relatively easy road and water access. Forest Service rented water tenders can add expense to the project and Forest Service engines may be difficult to schedule during wildfire or prescribed burning season. Pump and hose fitting need to be compatible between Forest Service engines and mix trucks. Water should be clean or potable to avoid plugging up the spray system.

Field Staffing and Operations

Commercial aerial spray operations are typically conducted with two people: a pilot and a mix master. For safety, cost and public relations, project managers should try to minimize the number of people in the project area during spray operations. Additional people increase exposure and may have nothing to do, creating a negative public perception. Spray contractors should be allowed to conduct the operation with a minimal amount of interruption from project staff. All on the ground project staff should have radio communication with each other and the pilot. Suggested staffing is shown below.

TABLE N – 1. SUGGESTED PROJECT STAFFING AND DUTIES

Position	Duties	Location
Project Manager	Direct and oversee project; Recon flight; Answer pilot questions about the application; Ensure project is within weather prescriptions; Record loads, herbicide use and cycle times; Maintain contract diary; Monitor and document weather; Review and approve invoices; Ensure project mitigation measures are applied; Help with buffer monitoring; Maintain project file and complete the project report.	Helibase and throughout the project area
Aerial Equipment Manager	Oversee the flight operations; Develop communication plan; Review and brief pilot on Project Aviation Safety Plan; Assist Project Manager with load and weather monitoring and documentation.	Helibase
Drift Card / Buffer Monitors	Place and pick up drift cards; Monitor and record weather in buffer areas; Report on the ground weather to pilot and project manager when treating next to buffer zones.	In buffer areas
Traffic Managers / Public Information staff	Secure access to the project area; Prevent unauthorized public access to the project area during treatment; Answer questions and provide short briefings on the project objectives and operations.	Roads and/or trails leading into the project area.

All project staff should be briefed on the project objectives, operations and duties prior to treatment day. Written briefs are suggested for traffic management staff and any others likely to encounter the public. Boxes or satchels should be prepared with all the necessary equipment and forms each person will need to do their job. Project staff will typically report to the office as early as 0400 or 0500 hours to allow for travel to the project area, so it is suggested you have everything organized and ready to go the day before.

APPENDIX N
AERIAL SPRAY GUIDELINES AND DRIFT MODEL RESULTS

Aerial Spray Recommendations

The treatment block should be marked with flagging to mark the block corners or clearly described and reviewed with applicator. It is be desirable to have a GPS system on board to record helicopter swaths, position, and boom on and off times and location.

In canyon areas, winds should follow the typical diurnal pattern of upslope during the day and down slope during the night. These diurnal winds result from heating and cooling of the surface. Clear skies with solar radiation reaching the surface during the day cause up canyon and upslope winds. Cooling that occurs after sunset generates upslope or drainage winds. Given that waterways/riparian areas are often located in the bottom of canyon areas, it is essential to avoid drift down canyon and downslope. Down canyon and downslope winds will likely occur on clear days following daytime hours. To prevent spray from drifting down canyon/downslope, winds should be up canyon and upslope. Also, inversion can result in spray drifting off site; winds indicate that an inversion is not present.

Avoid spray drift impacting non-target sites by taking the following steps (also see Appendix C Protection measures):

- When treating next to sensitive areas spray in the morning when up canyon and upslope winds are well established and blowing up canyon (most sensitive areas are down canyon). The specific time will need to be determined by real-time weather monitoring.
- Maintain boom pressure at less than 40psi.
- Monitor spray pressure during flight, since changes in pressure can change the application rates and may change the drop size.
- Use nozzles designed for medium to coarse droplet size (240 to 400 microns)
- Use drift agent to help maintain large droplet size.
- Check nozzles and review calibration with pilot.
- Begin the first swath 300 feet from any sensitive area.
- Mark boundaries so they are clearly understood by the pilot. Fly area with pilot prior to treatment to verify location. Use GPS to document boundaries and record treatment flight paths.
- Monitor treatment boundaries next to sensitive areas with spray deposit cards to detect any possible drift. Train people in how to handle the cards, interpret the cards (many things can contaminate the cards such as dew, moisture from hands, insects) and also document results. Card lines should also be placed in treated areas under full spray to serve as a reference.
- Monitor and record weather in the area. The weather should be monitored in real time for operational control and to help with the post-spray analysis. Strive for winds from 3 to 6 miles per hour or per label instruction. Do not treat if rain is predicted within next 24 hours.
- Consider using Forest Service Cramer-Barry-Grim (FSCBG) or AGDISP computer models to evaluate drift potential and to develop operational and drift protection measures prior to treatment.

Post Treatment Considerations and Tasks

Post treatment tasks may include:

- Monitor and document in the project file daily rainfall for up to a week after treatment
- Schedule reading of monitoring plots between 1 growing season and 1 year after treatment
- Read drift cards and complete a drift report
- Compile a treatment project file for reference for the next retreatment
- Add the project to the retreatment schedule
- Pick up ribbon and any other unit markings
- Complete contract daily diary and submitting original to the Contracting Officer
- Completing a Post Treatment Evaluation (FSH 2109.14 Ch 72.1)

FSM / FSH References

FSH 1909.15 Chapter 20 (Environmental Impacts Statements and Related Documents)
FSH 2080 Noxious Weeds
FSM 2100 Chapter 2150 Pesticide-Use Management and Coordination
R1 Supplement 2100-88-1 (some Forest may also have supplements)
FSM 2100 Chapter 2160 Hazardous Materials Management
FSH 2109-14 Pesticide Use
FSM 5711.11 Planning for Project Aviation Operations
FSH 6709.11 Health and Safety Code Handbook

APPENDIX N
AERIAL SPRAY GUIDELINES AND DRIFT MODEL RESULTS

ITEMS TO BRING ON AERIAL SPRAY PROJECTS

- ❑ Drift cards
- ❑ Drift card holders
- ❑ Zip lock bags
- ❑ Sharpie pens to write on zip locks
- ❑ WR BA EIS, ROD, Maps (EIS has spill plan / labels / MSDSs)
- ❑ Project File
- ❑ Radios
- ❑ Extra Batteries
- ❑ Communication Plan
- ❑ Ribbon
- ❑ Blank Diary forms
- ❑ Aerial Photos
- ❑ Wind meters
- ❑ Camera
- ❑ Amendment 11 to Forest Plan
- ❑ Calculator

CONTENTS OF TREATMENT PROJECT FILE (Reference FSH2109.14 Chapter 72.1)

1. Name and location of the target pest

2. Treatment objectives

3. Date of treatment

4. Pesticide application
   a. Equipment malfunctions
   b. Pesticide formulation problems
   c. Overlaps and/or skips noted
   d. Weather conditions
   e. Application timing
   f. Treatment costs

5. Treatment success in terms of:
   a. Pest population reduction
   b. Foliage protection (from defoliators) or growth reduction (as a result fo herbicide use).
   c. Acres covered

6. Monitoring results

7. Recommendations for follow-up and/or future projects.

TABLE N – 2. DRIFT MONITORING SUPPLIES

Item	Specifications	Source
Deposit Paper	White Kromekote coated both sides 0.006 weight, size 16.9 x 11 cm = 1mm Detects dyed droplets	Nationwide papers (Paul) 345 Schwerin St. San Francisco, CA 94119 415.586.9160 or 800.652.1326 X215 FAX 415.239.7871
Water sensitive paper (Syngenta)	Product # 20301-1; size 3" x 1" – pack of 50 Product #20301-2; size 3" x 2" – pack of 50	Spraying Systems Co. North Ave at Schmale Road Wheaton, IL 60188 630.665.5000 or AgWest (Montana distributor) 800.452.0010
Holders for deposit papers	Kromekote card holder (white plastic) for 16.9 x 11 cm card	Rick and Carl Borbons Acrylonics Labs 666 Stockton #c San Jose, CA 95126 408.998.8339
Holders for deposit papers	Kromekote card holder (yellow or orange plastic) for 16.9 x 11 cm card ($3 + each)	E and F Plastics (Frank) 2756 Aiello Drive San Jose, CA 95111 408.226.6672

LOAD RECORD EXAMPLE

Aerial Spray Project Load Record

Contract Number:______________________

Project Name:______________________

Date:______________________

Load #	Time Out	Time In	Unit	Prescription	Acres Trt'ed	Amt. Herbi	Cycle Time	Comments

Time	Location	Temp.	Wind / Direction	Rel. Humidity	Comments

DRIFT MODEL RESULTS

AGDISP model predictions were conducted by Harold Thistle, Ph.D., USDA Forest Service, Morgantown, WV to assist in developing aerial spray strategies for proposed applications to control noxious weeds on the Custer National Forest. The predictions can be used to plan operational methodologies, determine size of buffer strips to prevent or minimize sensitive area contamination, and decide under which wind and other atmospheric conditions to conduct aerial spraying.

Three commonly used aircrafts in Western Montana are the: Bell 47 Soloy, Bell 206BIII, and Hiller 12E. Table N - 1 lists the AGDISP model inputs.

TABLE N - 1: SPRAY CONDITIONS— AGDISP MODEL INPUTS[2]

Spray Conditions	AGDISP Model Inputs for		
	Hiller 12E	**Bell 206BIII**	**Bell 47 Soloy**
Operating Speed	40 mph	80 mph	50 mph
Formulation	Tordon/Picloram	Tordon/Picloram	Tordon/Picloram
Application Rate	2 gal/acre	2 gal/acre	2 gal/acre
Swath Width	40 feet	45 feet	45 feet
Temperature	70 deg. F.	70 deg. F.	70 deg. F.
Relative Humidity	60%	60%	60%
Wind Speed	6mph	6mph	6mph
Nozzle Vertical Distance	-8.70 feet	-9.01 feet	-8.07 feet
Nozzle Type and Orientation	CP/0 degrees	TeeJet D4-46/0 degrees	D8 Jet/45 degrees
Number of Nozzles	29	35	16
Rotor Diameter	35.43 feet	33.37 feet	37.17 feet
Nozzles	Evenly spaced over 100% of the boom	Evenly spaced over 100% of the boom	Evenly spaced over 100% of the boom
Wind Directions Crosswind	45 degrees (where the direction of a north wind is 0 degrees)	45 degrees (where the direction of a north wind is 0 degrees).	45 degrees (where the direction of a north wind is 0 degrees)

TABLE N – 2. SUMMARY FROM FIVE SIMULATIONS SHOWING THE AMOUNT OF EXPECTED HERBICIDE (OZ/ACRES) AT 100 AND 300 FEET INTERVALS.[3]

	Spray Condition – Release Height & Projected Deposition					
Feet downwind	**O1 – 10 FT oz/ac**	**O1 - 25 FT oz/ac**	**O2 - 10 FT oz/ac**	**O2 - 25 FT oz/ac**	**O3 - 10 FT oz/ac**	**O3 - 25 FT oz/ac**
100 FT	0.176	0.510	0.643	0.552	0.552	0.913
300 FT	0.006	0.044	0.083	0.114	0.096	0.206

Modeling runs demonstrate that:

- Most of the spray is deposited in the treatment block;
- There would be essentially no deposition in the sensitive areas with a buffer of 300 feet.

---

2 Release Height – 10 and 25 Feet Above Ground
3 The application rate is 2 gallons per acre.